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AUTOMOTIVE SERVICE SPECIALIST, A SUGGESTED GUIDE FOR A TRAINING COURSE.

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THE PURPOSE OF THIS TEACHING GUIDE IS TO SERVE AS A REFERENCE AND COURSE OUTLINE FOR THE INSTRUCTOR. IT WAS DEVELOPED BY A COLLEGE AUTOMOTIVE DEPARTMENT HEAD AND REPRESENTATIVES OF AUTOMOTIVE SERVICE INDUSTRIES, PETROLEUM INDUSTRIES, AND GARAGES. THIS COURSE IS ADAPTABLE TO PREPARATORY, UPGRADING, OR RETRAINING PURPOSES. UNITS ARE SERVICE ORIENTATION AND MAINTENANCE, ELECTRICAL AND FUEL SERVICE, AND SUSPENSION AND BRAKE SERVICE. EACH LESSON INCLUDES TIME ALLOCATION, TOOLS AND MATERIALS, TEACHING GUIDE, DISCUSSION TOPICS, LABORATORY ACTIVITY, AND SHOP ACTIVITY. EACH OF THE THREE UNITS REQUIRES 12 WEEKS OF INSTRUCTION, LASTING 7 HOURS PER DAY, 5 DAYS A WEEK. THE APPENDIX CONTAINS--HAND TOOLS AND SPECIALIZED TOOL KITS, GENERAL SHOP EQUIPMENT AND TOOLS, BASIC EQUIPMENT AND TOOLS, SUGGESTED OPERATING SUPPLIES, AND COST SUMMARY (FOR A CLASS OF 15 STUDENTS). A SELECTED BIBLIOGRAPHY CONTAINS REFERENCE MATERIALS, SPECIFICATION MANUALS, AND INSTRUCTIONAL AIDS. THIS DOCUMENT IS ALSO AVAILABLE AS FS 5.287--87015 FROM THE SUPERINTENDENT OF DOCUMENTS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C. 20402, FOR $0.45. (EM)

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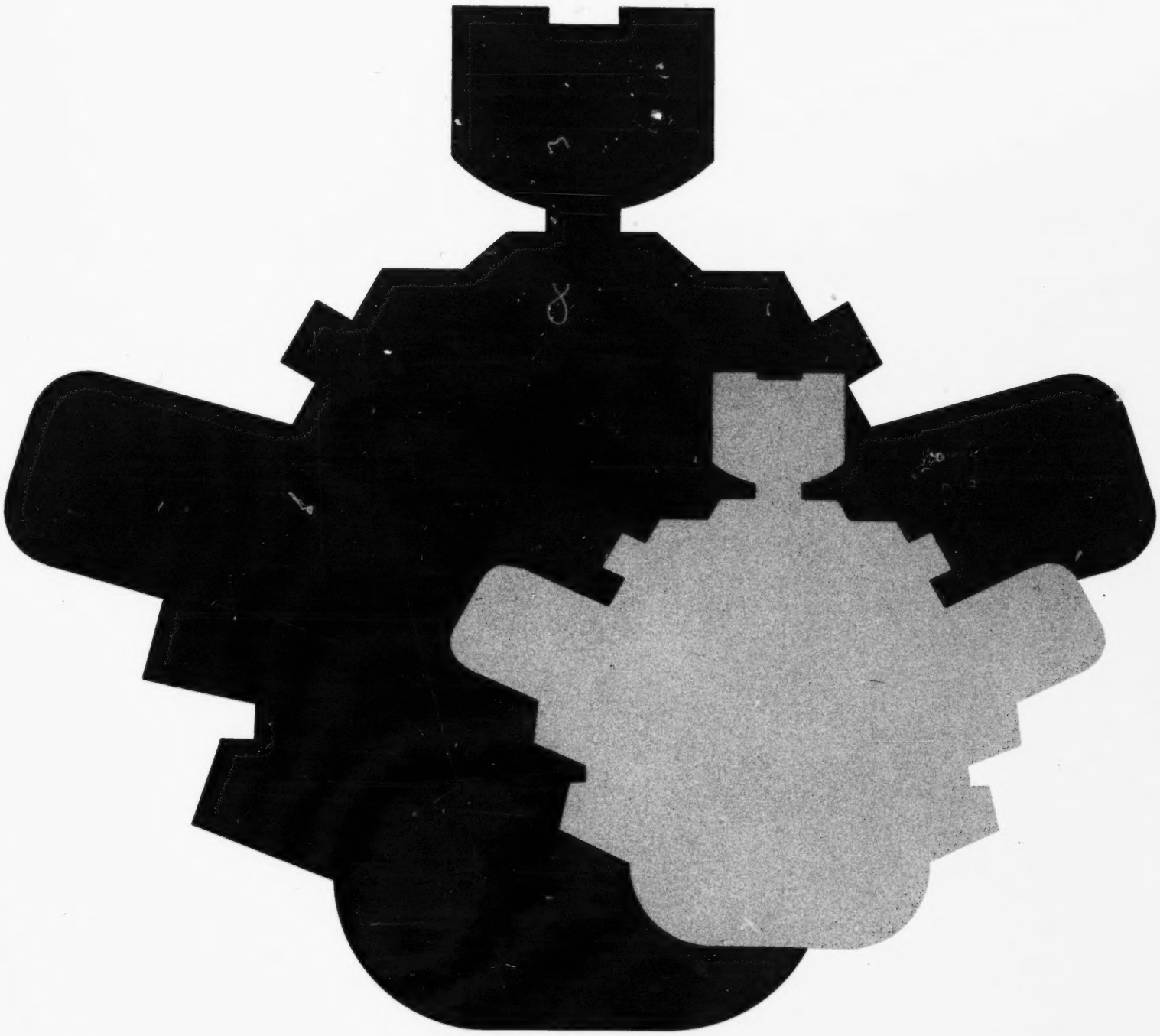

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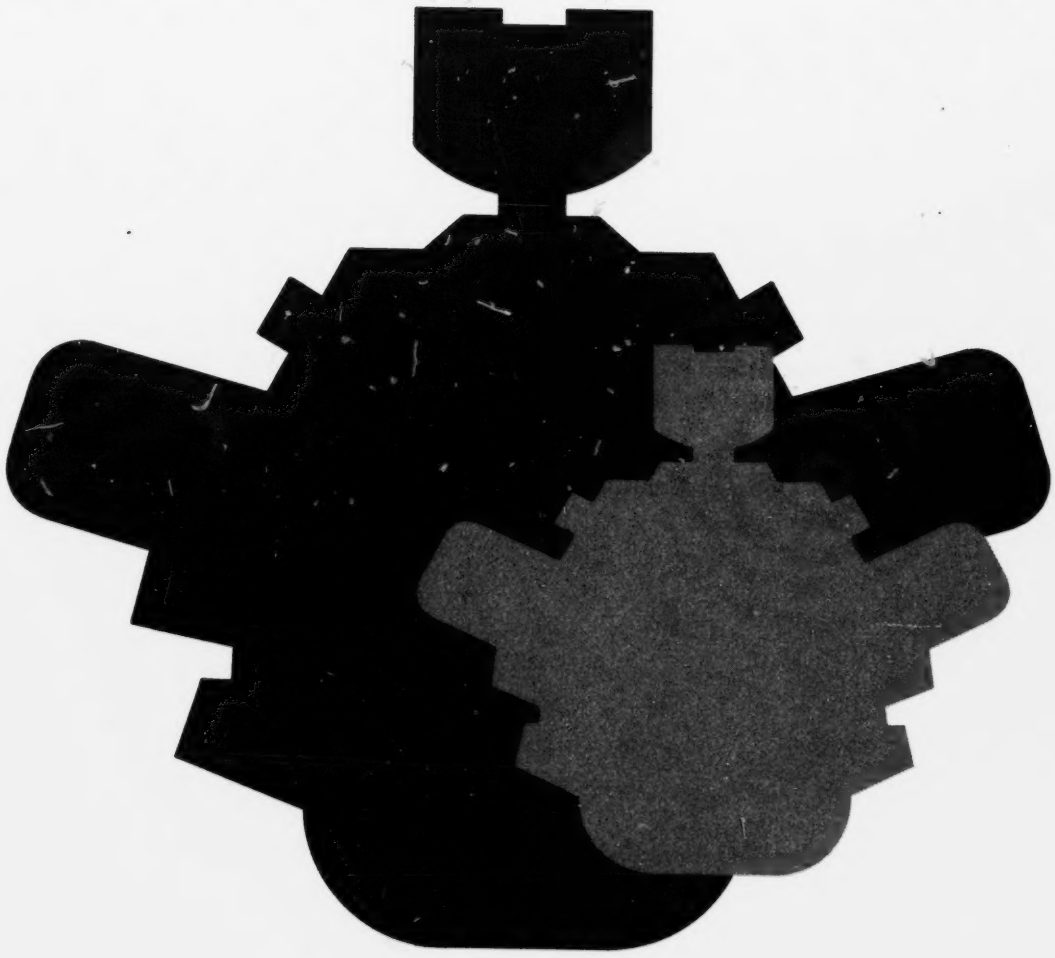
AUTOMOTIVE SERVICE SPECIALIST



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FOREWORD

The occupation of Automotive Service Specialist has become important in the national economy as a result of society's great dependence upon automobiles for transportation. To perform satisfactorily, today's highly developed automobiles must be serviced regularly.

Industries that service automobiles have encountered vexing problems in their efforts to recruit well-trained personnel to maintain vehicles for the American public. The acute need for competently trained persons has created a demand for the expansion of training resources.

This guide, prepared as a reference for developing a course to be used in the preparation of the Automotive Service Specialist, was developed under the guidance of representatives of the automotive service industries, petroleum industries, and garage owners, who volunteered their services.

Flexible in content, the guide can be used in developing untrained personnel, or it may be used to upgrade or retrain workers in the automobile servicing field. The sequence of the units of instruction may be changed to meet the needs of the individuals being served.

The Automotive Service Specialist will perform simple repair and part replacement jobs, and under certain conditions may make major repairs which require a high level of skill and knowledge. Care was exercised in the selection of subject matter to include only that which is essential in preparing persons to qualify for the job of an Automotive Service Specialist and to assure that the material could be well covered in a reasonable period of time.

The U.S. Office of Education acknowledges with appreciation the following individuals and the companies and organizations they represent, who advised us concerning the instructional materials included in the guide for the preparation of the Automotive Service Specialist:

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Walter M. Arnold
Assistant Commissioner
for Vocational and Technical Education

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GUIDE FOR A TRAINING COURSE FOR THE AUTOMOTIVE SERVICE SPECIALIST

INTRODUCTION

THIS GUIDE IS DIVIDED into 3 sections, each of which will require 12 weeks of course instruction of 7 hours per day and 5 days per week. The total length of the course is 36 weeks.

Merchandising is a vital part of the Automotive Service Specialist's job. In addition to possessing the essential skills and knowledge for rendering services, he must be able to sell necessary services and products to customers. He must also be able to assure these customers that the job he performs for them is executed properly and efficiently.

Safety procedures, precautions, and instructions must be stressed in all discussion sessions and demonstrated by the teacher in all laboratory and shop activities. Safety must be emphasized to a point that the trainees will develop attitudes about safe practices which will be inherent in their performance on the job.

To avoid considerable duplication, the subject of safety has not been repeated in each unit. The instructor is urged, however, to emphasize its importance and to integrate the subject into each day's activities.

The ability to merchandise, like the ability to practice safety, must be developed over a period of time. The instructor should devote as much time as possible to both of these subjects during the presentation of each instructional unit.

This part of the course is of major concern to the industry and could well be the determining factor in the trainee's initial employability and the tenure of his employment.

A. DEFINITION OF OCCUPATIONAL TITLE

Automobile Service Mechanic (auto. ser.) 7–81. Automotive Service Specialist. Performs minor repair and tune-up of motor vehicles. Using hand tools replaces and adjusts fuel, electrical, and cooling system components, such as carburetor, fuel and water pumps, distributor, voltage regulator, coil and generator. Replaces and adjusts system component parts, such as distributor breaker points and generator brushes. Cleans spark plug electrodes with sandblasting machine. Sets spark plug gap, using feeler gage. Replaces defective chassis parts, such as shock absorbers, tie-rod ends, ball-joint suspension, brake shoes, and wheel bearings. Installs automobile accessories, such as oil and air filters, windshield wiper blades, fanbelts, and batteries. Fills fuel tank of vehicles with gasoline or diesel fuel. Adds oil to crankcase and refills with new oil. Lubricates moving parts of chassis with grease, using grease-gun. When working in a service station may be designated as Automobile Service Station Mechanic.

B. PLAN OF THIS TRAINING COURSE

This guide has been developed to provide a maximum amount of flexibility in scheduling training activities. The first of the three sections is a basic service unit, primarily composed of various subjects that should be mastered before a trainee becomes employable. The second and third sections cover areas of specialization which can be used to upgrade or retrain persons who are currently employed but who must gain a more versatile background to hold their present job or to qualify for a better one.

The guide, prepared to serve as a reference for the instructor, offers a plan for the presentation of the material to be covered. This material should be considered as an outline for a course of instruction rather than as a complete course of study.

Each instructional unit in the outline is broken down into subdivisions, which encourages a more comprehensive and organized coverage of the unit. These subdivisions are: Introduction, Time Allocation, Tools and Materials, Teaching Techniques, Discussion Topics, and Laboratory Activity or Shop Activity.

Introduction: In this subdivision the reasons for teaching the unit are discussed. The material included here is for the purpose of developing the interest of the trainee to learn the content of the unit. The instructor may further encourage the development of the trainee's interest by explaining in outline form the subject assignments of the unit that involve the acquisition of knowledge and skill.

Time Allocation: The suggested time allocation will vary with each instructor, considering the abilities and backgrounds of the trainees.

Tools and Materials: The list provided suggests tools and materials to be used in the particular instructional unit.

Teaching Guide: This subdivision gives suggestions for presentation. Instructors should use methods that will accomplish the objectives in the most efficient manner. Provision should be made for demonstrations when needed for the adequate understanding of the unit as well as complete coverage of all necessary information.

Discussion Topics: The classroom outline is composed of topics that need to be thoroughly understood in order to do a specific job. Informal discussion is recommended. It is further suggested that the teacher use as many visual aids as possible.

Laboratory Activity: Demonstrations may be provided in the laboratory. These may be termed controlled learning sessions. After the subject has been discussed, the techniques must be demonstrated by the teacher and later practiced by the trainees. If necessary, this part could be held in the shop area.

Shop Activity: The applied part of the unit is conducted in the shop. Instruction here involves trainee participation almost exclusively. Ample time should be scheduled for shop activity in order to permit the trainees to practice procedures and to develop their skill and speed in completing the assignment.

Section I.
SERVICE ORIENTATION AND MAINTENANCE

GENERAL SERVICING

Instructional Unit	Number of hours in—		
	Classroom	Laboratory	Shop
1. Job Orientation	2	0	0
2. Shop Safety Procedure	3	2	0
3. Shop Orientation	3	2	4
4. Introduction to the Automobile	14	14	0
5. Wheel Bearing and Seal Service	1	4	28
6. Cooling System Service	2	4	28
7. Spark Plug Service	1	2	5
8. Exhaust System Service	1	1	28
9. Battery Service	2	1	3
10. Lighting Circuit Service	1	1	7
11. Automatic Transmission Minor Service	5	35	10
12. Tire Service	2	4	14
13. Minor Brake-Adjustment Procedures	3	14	28
14. Automobile Cleaning Service	1	0	28
15. Lubrication and Preventive Maintenance Procedure	2	5	105
Total	43	89	288

The purpose of the first four instructional units in this section is to orient the trainee to the job of automotive service specialist; to teach and have him practice safety in the shop; to orient him with the proper shop organization that will promote speed, efficiency, and safety in auto repair work, which must be done with great care and accuracy if it is to be satisfactory. The trainee must understand and know how to apply technical information to his work. He must be able to follow definite procedures, must check his work carefully, and have a sense of responsibility for maintaining a high standard of workmanship. The trainee must learn to analyze each job before starting to work in order to save time, minimize mistakes, and prevent accidents. The trainee will be introduced to a background knowledge of the components of the automobile and their operating principles.

Instructional units 5 through 15 provide training in the identified basic phases of automotive service and preventive maintenance procedures which will prepare the trainee in the skills and knowledge necessary for employment as an automotive service specialist. The trainee must possess these basic skills before he can become employable and later progress to more specialized areas of automotive service, or become a general automobile mechanic.

Unit 1. JOB ORIENTATION

IN ALL SERVICE CENTERS, the employer is responsible for his employees and the success of his business. He is the person who has to make the decisions affecting his business, and is responsible for keeping his service business growing. He is responsible for developing manpower to adequately handle his

service business and is also interested in developing his employees to become better citizens. Too often, the technically competent employee loses his job because he does not know how to get along with his employer, other employees, or the customers. Employees can help their employer succeed, and thus better their own jobs, if they understand some of the basic principles of employer-employee relations as well as customer relations. An understanding of these basic principles is the objective of this unit.

TIME ALLOCATION

Classroom, 2 hours

TEACHING GUIDE

Encourage the trainees to participate in the discussion of the following topics. Use as many practical examples as possible during the discussion; for example, ask the trainees to observe carefully the people who serve them the next time they purchase gasoline for their cars. Discuss the trainees' comments on these observations in a subsequent class.

DISCUSSION TOPICS

I. Job opportunities in the automotive service industry
   - A. Types of jobs available
   - B. General working conditions
   - C. Importance of the serviceman's job
   - D. Requirements for job procurement
     1. Willingness to work
     2. Technical training
     3. Product training
     4. Positive attitude

II. Customer relations
   - A. Employee's appearance
     1. Clean uniforms, including shined shoes and belt
     2. Clean shave daily
     3. Haircut regularly
     4. Always wear a smile
   - B. Use of language
     1. Greet the customer courteously
     2. Avoid use of vulgar language
     3. Avoid controversial subjects
   - C. Building customer confidence
     1. Show a sincere interest in your job
     2. Show a sincere interest while servicing customer's automobile
     3. Be sure customer is satisfied with services rendered
     4. Sell only what customer needs
     5. Advise customer on his future needs
   - D. Telephone technicques
     1. Answering the telephone
        a. Identify company and person speaking
        b. Speak directly into mouthpiece
        c. Speak slowly and clearly
        d. Be courteous and complimentary—every caller may be a prospective customer
        e. Avoid banging receiver when conversation has been completed
     2. Taking messages
        a. Hour and date
        b. Name and identity of caller
        c. Exact message
        d. Caller's telephone number
        e. Initials of person accepting call
     3. Giving information
        a. Release business information only on authority
        b. When making appointments, be specific about day, time, and the work to be done
     4. When others are telephoning
        a. Leave room when personal calls are received by others
        b. Close doors or reduce noise for those using telephone
        c. If necessary to furnish information to the person using the telephone, write it on paper to hand to him rather than interrupting him

III. Employer–employee relations
   - A. Physical improvements when idle
     1. Working area cleanliness
     2. Dusting and cleaning display merchandise
     3. Stocking merchandise on shelves

4. Repairing tools and equipment
5. Assisting employer with detail work

B. Assist with public relations
1. Be loyal to your employer
2. Be loyal to your company
3. Use the products you sell
4. Help solicit new business
5. Learn to handle complaints

C. Offer suggestions and ideas
1. Respect the business as if it were your own
2. Offer constructive criticism
3. Keep abreast of new developments in the trade
4. Be alert for good ideas from your competition

Unit 2. SHOP SAFETY PROCEDURE

SHOP SAFETY PROCEDURES can and will be practiced by servicemen when they have developed the proper attitude toward the subject. The purpose of this unit is to acquaint the trainees with shop safety procedures. Talking about shop safety procedures is not enough; they must be continually practiced for a long period of time so as to become habitual. This unit is intentionally placed early in the training guide so a shop safety plan can be set up and practiced during the remainder of the training program.

TIME ALLOCATION

Classroom, 3 hours; laboratory, 2 hours

TEACHING GUIDE

Discuss the following topics using examples to strengthen teaching. Arrangements should be made with the local fire chief for a demonstration of methods of fighting oil fires. Demonstrate the proper use and maintenance requirements of equipment. Assign trainees cleanup responsibilities and show them how to do their assigned tasks.

DISCUSSION TOPICS

I. Personal safety
A. Serviceman's value to his family
1. As a wage earner
2. Loss of earning power if permanently injured

B. Serviceman's value to his employer
1. Loss of company income
2. Loss of a trained employee

C. Serviceman's clothing
1. Clean uniform
2. Hard-toe safety shoes
3. Remove rings and metalbanded wrist watches while at work

D. Safety glasses

II. Building safety
A. Location of entrances and exits
B. Fire fighting equipment: Type and location
C. Maintenance program
1. Floor maintenance
2. Lighting and windows
3. Major equipment items
a. Air compressors and lines
b. Hoists
c. Heating fans
d. Electrical outlets and cords

D. Exhaust system
E. Safety information—availability by telephone
F. Hazard areas well marked
G. Waste storage
H. Possible insurance company restrictions
I. Fire marshal's approval of building for the type of operation

III. Hydraulic equipment
A. Use of jack stanchions
B. Hydraulic equipment inspection
C. Jack handle trigger use

IV. Electrical equipment
A. Importance of grounding electrical tools
B. Condition of electrical tool cords
C. Individual equipment safety
1. Dangers of bench grinders and importance of guards and eye shields
2. Dangers of wire wheels and importance of guards and eye shields

V. Air-operated tools
   A. Dangers of high-speed tools
   B. Air-tool maintenance and safety
   C. Dangers of air jacks
      1. Speed of operation
      2. Triggering devices for operation
VI. Hand tools
   A. Proper use of hand tools
   B. Evaluation of tool conditions
   C. Selection of proper tool for the job at hand
   D. Caution against carrying sharp hand tools in pockets
VII. Chemicals
   A. Hot tank chemicals and hazards
   B. Cold tank chemicals and hazards
   C. Steam cleaning chemicals and hazards
   D. Skin protection when using chemicals
   E. Eye protection when using chemicals
VIII. Clean-up program
   A. A tool rack for hand tools
   B. A place for all equipment
   C. A routine cleaning and inspection schedule
   D. Instruction on how to clean
IX. Safety while servicing the automobile
   A. Cooling system safety
   B. Smoking hazards when working near:
      1. Freshly charged batteries
      2. Gasoline
   C. Testing or trouble-shooting on a running engine
      1. Fanbelts
      2. Fans
      3. Pulleys
      4. Air cleaner as fire arrester
   D. Welding safety
      1. Use of goggles
      2. Instruction on proper use of equipment
   E. Availability of fire fighting equipment
X. Safety while road testing the automobile

SUGGESTED LABORATORY ACTIVITY

I. Demonstrate use of all lifting equipment
II. Demonstrate lifting technique with the human body
III. Demonstrate use of all power tools
IV. Assign trainees to clean-up duties and show them how to perform their respective jobs

Unit 3. SHOP ORIENTATION

EFFICIENT SHOP OPERATION is often the result of a well-organized shop orientation program. Trainees are usually eager to achieve the standards established by their instructors and to learn the proper use of equipment and hand tools that will be used throughout the training program. Good housecleaning practices can be achieved only after the trainee understands why and how this job must be done. Thus, the objectives of this unit are simply to demonstrate shop operation procedures to the trainee so he will be better prepared to work and learn in the shop portions of this program.

TIME ALLOCATION

Classroom, 3 hours; laboratory, 2 hours; shop, 4 hours

TOOLS AND MATERIALS

I. Specification manuals
II. Parts catalogs
III. Representative sampling of fasteners
IV. Flaring tools
V. Tap and die set
VI. Hand tool kit

TEACHING GUIDE

Encourage the trainees to participate in the discussion and demonstrations of the following topics. Stress that everything discussed in this section is basic information needed by today's servicemen. Many of the fundamentals touched on in this section will be used over and over again in subsequent sections.

DISCUSSION TOPICS

I. Training program schedule
   A. Work schedule
      1. Starting time
      2. Break time
      3. Lunch time
      4. Dismissal time
   B. Attendance requirements
   C. Dress requirements

II. Trainee automobile regulations
   A. Check trainee's driver's license
   B. Location of authorized parking lot
   C. Regulations pertaining to use of trainee's car in the shop program

III. Use of service and training manuals
   A. Service manuals
   B. Lubrication manuals
   C. Parts catalogs and nomenclature
   D. Specifications and special data manuals

IV. Shop practice and operations
   A. Use of service tools and equipment
      1. Hoists
      2. Lifting equipment
      3. Hand tools
   B. Location of special electrical switches
      1. Exhaust system
      2. Overhead doors
      3. Light switches
      4. Wall outlets
      5. Air compressor
   C. Identification and use of fasteners and brass fittings
   D. Shop maintenance schedule
      1. Trainee responsibility
      2. Maintenance department responsibility

LABORATORY ACTIVITY

I. Demonstrate the use of the tap and die set
II. Demonstrate how to make copper tubing connections
   A. Compression type
   B. Flare type
III. Demonstrate methods of locating part numbers and prices in the parts catalogs, with special attention to packaging techniques
IV. Demonstrate methods of locating specific technical data from specification manuals

SHOP ACTIVITY

I. Give trainees a list of parts for which they must find part numbers and prices from the parts catalogs
II. Ask trainees for specific, detailed instructions for servicing a given component, necessitating their locating and interpreting the data from technical publications
III. Repair a damaged thread
IV. Drill and tap a hole

Unit 4. INTRODUCTION TO THE AUTOMOBILE

THIS UNIT COVERS fundamental topics presented in a way to make it possible for trainees, lacking employment experience in the automotive field, to gain background knowledge of the automobile. Fundamental topics are discussed so that the trainees can acquaint themselves with this essential information.

TIME ALLOCATION

Classroom, 14 hours; laboratory, 14 hours

TOOLS AND MATERIALS

It is suggested that automobiles from all American manufacturers as well as import models be made available so that they may be used as the various subjects are discussed.

TEACHING GUIDE

Discuss the following topics in sufficient detail so the trainee has an understanding of each unit's operation. Trainee participation in these discussions should be encouraged. Any direct applications using the automobile as an instructional aid should also be encouraged. The technical related information is quite long and demonstrations or direct applications on a vehicle should be used as often as possible.

DISCUSSION TOPICS

I. Automobile manufacturers and makes of cars not over 8 years old
   A. General Motors Corporation
   B. Ford Motor Company
   C. Chrysler Motors Corporation
   D. American Motors
   E. Imports (leading)

II. Introduction to the engine
   A. Components of the basic gasoline engine
   B. Engine types
   C. Principles of engine operation
   D. Principles of the 4-stroke cycle engine
   E. Principles of the 2-stroke cycle engine

III. Introduction to the fuel and exhaust system
   A. Components of the fuel and exhaust system
   B. Purpose of the components
      1. Fuel pump
      2. Carburetor
      3. Air cleaners
   C. Description of exhaust components

IV. Introduction to the ignition and electrical system
   A. Components of the ignition and electrical system
   B. Purpose and function of each electrical component

V. Introduction to crankcase lubrication system
   A. Components of the crankcase lubrication system
   B. Description of crankcase ventilation system
   C. Description of various oil-feed systems
   D. Description of oil-pump and relief-valve operation

VI. Introduction to the cooling system
   A. Components of the cooling system
   B. Description of the air cooled systems

VII. Introduction to transmissions
   A. Types of transmissions
      1. Automatic
      2. Standard
   B. Components of the clutch assembly
   C. Description of clutch operation
   D. Description of fluid coupling operation
   E. Description of torque converter operation
   F. Description of the transaxle operation
   G. Description of drive-line components

VIII. Introduction to the steering system
   A. Components of the steering system
   B. Description of wheel alignment
   C. Description of steering mechanism operation
   D. Description of power steering systems

IX. Introduction to the brake system
   A. Components of the various brake systems
   B. Description of power brake operation
   C. Description of parking brake types

X. Introduction to the frame and suspension system
   A. Description of suspension system
   B. Types of frames
   C. Description of independent front-wheel suspension
   D. Description of independent rear-wheel suspension
   E. Description of torsion-bar suspension

Unit 5. WHEEL BEARING AND SEAL SERVICE

AUTOMOBILE MANUFACTURERS are recommending longer time and mileage intervals before servicing wheel bearings. The service has not been eliminated nor has the importance of this service become less vital. Total failure of wheel bearings could lead to death and destruction on the highway. The automobile owner will have to be reminded of this needed service, and it is the responsibility of those who are engaged in the service business to sell this service. The purpose of this unit is to explain and demonstrate to the trainee the proper techniques of servicing wheel bearings.

TIME ALLOCATION

Classroom, 1 hour; laboratory, 4 hours; shop, 28 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Torque wrench—range 0–150 foot pounds
III. Bearing packer
IV. Grease cap puller
V. Wheel bearing grease
VI. Rear wheel and axle puller
VII. Grease seal remover
VIII. Grease seal installer

TEACHING GUIDE

Discuss the following topics with the trainees. Demonstrate the complete service procedure on one front wheel of an automobile, then select a trainee to do the same on the other side of the same automobile. Watch him closely and ask other trainees to tell him what to do. This will encourage class participation in the demonstration. Repeat the same procedure for rear wheel bearing service. After the demonstration, have the trainees perform these service operations on other automobiles.

DISCUSSION TOPICS

I. Front wheel bearing and seal service
  A. Remove the front wheel hub and drum assembly
  B. Front wheel bearing assembly nomenclature
  C. Types of bearings used
  D. Types of grease seals used
  E. Methods of removing grease seals
  F. Proper methods of cleaning bearings
  G. Proper methods of repacking front wheel bearings
    1. Hand method
    2. Wheel bearing packer method
    3. Check compatibility of lubricants
  H. Procedure for installing inner bearing assembly and grease seals
    1. Procedure for installing spindle nut and cotter pins

II. Rear wheel bearing and seal service
  A. Methods of removing rear axle and bearing assembly
  B. Rear axle and bearing nomenclature
  C. Types of bearings used and service requirements
    1. Tapered roller bearing—repack or replace
    2. Ball bearing—replacement
    3. Inner and outer seal replacement
  D. Types of seals used
  E. Adjustment of rear axle end play
  F. Bleed brake wheel cylinder and/or hydraulic system (See Brake Service Procedure—Sec. III)

LABORATORY ACTIVITY

I. Demonstrate the complete procedure for servicing front wheel bearings and seals

II. Demonstrate the complete procedure for servicing rear wheel bearings and seals

SHOP ACTIVITY

I. Service wheel bearings and replace seals
II. Select an automobile that requires rear wheel bearing service (packing) and perform all necessary operations according to specifications

Unit 6. COOLING SYSTEM SERVICE

IT HAS BEEN SAID that the cooling system of an automobile throws off enough heat to warm a small house on a zero-degree winter day. The radiator must be able to dissipate this tremendous amount of heat or the excess heat will destroy the engine. The life of the engine is partially due to the efficient operation of the cooling system. The purpose of this unit is to offer the trainees an understanding of the operation and servicing of this system.

TIME ALLOCATION

Classroom, 2 hours; laboratory, 4 hours; shop, 28 hours

TOOLS AND MATERIALS

I. Radiator hydrometer
II. Radiator pressure tester
III. Cooling system specification charts
IV. Thermostat tester
V. Hand tool kit
VI. Reverse flushing nozzle
VII. Fan-belt tension gauge

TEACHING GUIDE

Discuss the following topics in detail and then demonstrate the various cooling system tests. Following the demonstration ask the trainees to check and test cooling systems.

DISCUSSION TOPICS

I. Function of the cooling system
  A. Absorption of heat
  B. Circulation of heat to the radiator
  C. Radiation of heat to passing air
  D. Control of temperature

II. Components of the cooling system
  A. Radiator and radiator cap
  B. Water pump and fan
  C. Fan belts
  D. Radiator hose connections
  E. Block and head cooling chambers
  F. Cooling system gaskets
  G. Heater radiator
  H. Heater hose connections
  I. Thermostat types
  J. Coolant mixes under special conditions
    1. Air conditioning
    2. High altitude
    3. Aluminum blocks

III. Classification of cooling system malfunctions
  A. Overheating
  B. External leakage
  C. Internal leakage
  D. Overcooling

IV. Trouble-shooting the cooling system
  A. Check engine temperature
    1. Engine too hot
    2. Engine too cold
  B. Check for coolant loss
  C. Locate likely cause of trouble
    1. Hot engine
      a. External leakage
      b. Overflow loss
      c. Poor circulation
      d. Poor air flow
      e. Faulty thermostat
      f. Blocked overflow pipe
    2. Cold engine
      a. External leakage
      b. Internal leakage
  D. Use of hydrometer (cooling system)
    1. How to set hydrometer
    2. How to interpret readings
    3. How to use hydrometer
    4. How to clean hydrometer
  E. Use of cleaning and sealing chemicals
    1. Preparation of system
    2. Interpreting manufacturers' instructions
    3. Neutralizing system after using chemicals
    4. Test cleaning results

LABORATORY ACTIVITY

I. Servicing the cooling system
   A. Drain radiator and engine block
   B. Clean and flush system
   C. Test thermostat
   D. Inspect condition of all system connections
   E. Refill system and pressure test for leaks
   F. Test radiator cap-over-flow pipe
   G. Clean radiator air passages
   H. Check pump for noise
   I. Inspect and adjust fan belts
II. Cleaning the cooling system
   A. Clean system with chemicals
   B. Reverse-flush the system under pressure using air and water
III. Winterizing the cooling system
   A. Drain and flush system
   B. Tests for leaks
      1. External
      2. Internal
   C. Test thermostat
   D. Add winterizing solution
      1. All-season antifreeze
      2. Boil-off antifreeze
   E. Test solution with hydrometer
   F. Test accuracy of heat gauge
IV. Show and explain the function of automatic transmission cooler lines

SHOP ACTIVITY

I. Clean and test cooling system on an automobile
II. Chemically clean cooling system
III. Reverse pressure-flush radiator and block using air and water
IV. Winterize cooling system
V. Adjust all belts on the automobile
VI. Clean air passages in radiator
VII. Check automatic transmission cooler lines for leaks
VIII. Remove and replace fan belts
IX. Remove and replace upper and lower radiator hoses
X. Remove, test, and replace thermostat

Unit 7. SPARK PLUG SERVICE

SPARK PLUGS are constantly exposed to burning fuel and consequent high temperatures. All plugs accumulate combustion deposits that must be removed in order for the plug to maintain operational efficiency. The purpose of this unit is to acquaint the trainees with spark plug construction, types, cleaning, and gapping procedures.

TIME ALLOCATION

Classrom, 1 hour; laboratory, 2 hours; shop, 5 hours

TOOLS AND MATERIALS

I. Hot, cold, and medium-range plugs
II. $\frac{13}{16}$ socket $\frac{3}{8}$ drive
III. Flex handle ratchet wrench $\frac{3}{8}$ drive
IV. Spark plug regapping gauge
V. Plug cleaning machine
VI. Spark plug specification and conversion charts
VII. Spark plug gaskets
VIII. Spark plug file
IX. Plug wire removing tool

TEACHING GUIDE

After discussing the following topics, demonstrate the plug cleaning and gapping procedure. Trainees should clean and gap plugs which have been in use in automobiles and practice merchandising techniques.

DISCUSSION TOPICS

I. Spark plug construction
  A. Regular plugs
  B. Resistor plugs
  C. Projected core-nose plugs
  D. Long-reach-type plugs
II. Spark plug heat range
  A. Plug type
    1. Regular
    2. Hot
    3. Cold
  B. Specification chart heat-range identification
III. Analyzing plug conditions
  A. Normal plug wear
  B. Worn-out plugs
  C. Carbon-fouled plugs
  D. Oil-fouled plugs
  E. Burned electrodes
  F. Plug glazing
IV. Factors affecting plug performance
  A. Gap condition
  B. Reverse polarity
  C. Wire crossfiring in the secondary
  D. Faulty fuel system
  E. Faulty ignition system
  F. Intake manifold leak
  G. Oil pumping

LABORATORY ACTIVITY

I. Test spark plugs on a comparator-type machine
II. Clean spark plugs using plug-cleaning machine
III. File and reset plug gap
IV. Demonstrate use of tools and the correct method of plug removal from the engine

SHOP ACTIVITY

I. Remove set of plugs from automobile
II. Analyze plug condition
III. Clean and reset gap
IV. Reinstall plugs

Unit 8. EXHAUST SYSTEM SERVICE

THE EXHAUST SYSTEM serves two purposes: First, to keep deadly carbon monoxide gas from entering the automobile, and, second, to dampen the sound of the engine exhaust. The purpose of this unit is to help the trainee understand how to inspect and service an automobile exhaust system.

TIME ALLOCATION

Classroom, 1 hour; laboratory, 1 hour; shop, 28 hours

TOOLS AND MATERIALS

I. Manifold heat-control valve solvent
II. Exhaust system tool kit

TEACHING GUIDE

The teaching of this unit could best be done in the shop area, using the automobile exhaust system as the teaching aid. After stressing the importance of checking the system for safety purposes and discussing the topics, demonstrate repair of a typical faulty exhaust system. Trainees should service exhaust systems until a reasonable rate of service time is achieved.

DISCUSSION TOPICS

I. Components of the exhaust system
  A. Exhaust manifolds
  B. Manifold heat-control valve
  C. Exhaust pipe
  D. Muffler
  E. Tail pipe

F. Crossover pipe
G. Resonators and intermediate pipes
H. Clamps and brackets

II. Inspecting exhaust system (on hoist)
A. Visual inspection
B. Run engine; check for leaks

III. Exhaust system troubles
A. Rattle in muffler
B. Excessive noise
C. Rattle in exhaust system
1. Component striking floor pan
2. Component striking frame
3. Defective hangers
D. Clogged exhaust system causing engine to overheat and lose power
1. Muffler filled with water
2. Muffler installed wrong
3. Badly kinked tail pipe
4. Clogged tail pipe

IV. Procedure for removing damaged components

V. Procedure for replacing new components

VI. In-the-car adjustments and repairs
A. System alignment
B. Replacing brackets and clamps

LABORATORY ACTIVITY

I. Demonstrate use of air-operated muffler tools
II. Demonstrate use of hand-muffler tools
III. Demonstrate replacement of all exhaust system components

SHOP ACTIVITY

I. Trainees should repair and/or replace exhaust system components

Unit 9. BATTERY SERVICE

THE STORAGE BATTERY is the heart of the automotive electrical system. In spite of its vital importance, however, the battery is one of the most neglected items on the vehicle. The purpose of this unit is to help the trainee understand how to service a battery properly, how to install new batteries, and how to merchandise batteries.

TIME ALLOCATION

Classroom, 2 hours; laboratory, 1 hour; shop, 3 hours

TOOLS AND MATERIALS

I. Battery water container and filler syringe
II. Battery cable puller
III. Battery cable pliers
IV. Terminal cleaner
V. Voltmeter: 0–16-volt range
VI. Battery charger
VII. Battery hand tools
VIII. Battery carrier or cart
IX. Battery hydrometer

TEACHING GUIDE

Discuss the following topics and then demonstrate the service procedures. The trainees should then practice these service procedures on batteries in automobiles.

DISCUSSION TOPICS

I. New battery installation
A. Selection of proper battery
B. Preparing battery for installation
1. Dry charged batteries
2. Wet batteries
C. Factors affecting battery life
1. Overcharging factors
2. Undercharging factors
D. Standard battery warranty
E. Battery rating systems

II. Checking and charging batteries
  A. Use of hydrometer
  B. Reading the hydrometer
  C. Temperature corrections
  D. Maintaining the hydrometer
  E. Slow-charging batteries
  F. Boost-charging batteries

III. Storing batteries for resale
  A. Selection of stock
  B. Rotation of stock
  C. Guarding against self-discharge
  D. Special precautions for storing wet batteries
  E. Special precautions for storing dry charged batteries

LABORATORY ACTIVITY

I. Service the battery in the car
  A. Clean the top of the battery
  B. Inspect and service battery cables
  C. Service battery posts
  D. Service the battery holddown
  E. Reseal battery case leaks with compounds
  F. Make hydrometer tests
  G. Inspect battery cap vents
  H. Add water to battery cells
  I. Boost charge battery

SHOP ACTIVITY

I. Remove battery from engine compartment
II. Clean battery
III. Clean cable ends and battery posts
IV. Service battery holddown
V. Reinstall battery
VI. Adjust liquid level
VII. Boost charge battery

Unit 10. LIGHTING CIRCUIT SERVICE

THE LIGHTING CIRCUIT on the automobile is generally trouble free other than occasionally needing a replacement bulb or an adjustment of the headlights. Customers expect immediate service when they encounter a bulb problem and this service can be rendered if the serviceman has had some experience in servicing the circuit. The purpose of this unit is to acquaint the trainees with the various methods of getting to the bulbs for replacement, aiming headlights, and a general trouble-shooting technique for locating trouble in the directional signal circuit.

TIME ALLOCATION

Classroom, 1 hour; laboratory, 1 hour; shop, 7 hours

TOOLS AND MATERIALS

I. Small blade-type screw driver
II. A number 1 and number 2 phillips screw driver
III. Headlight aiming device
IV. Bulb and fuse specification chart

TEACHING GUIDE

This unit could well be conducted in the shop area. Automobiles that incorporate different types of bulb access should be in the shop. Explanations on the various types encountered would then be more practical. Trainees should spend sufficient time learning where the bulbs are generally located and how to get to them in order to replace them quickly.

DISCUSSION TOPICS

I. Description and location of lights found on present-day automobiles
  A. Headlights
  B. Turning and parking
  C. Under hood
  D. Dashboard

E. Courtesy
F. Trunk
G. Stop and tail
H. Back-up
I. License plate
J. Glove compartment

II. Bulb access, by light type
A. Parking and directional
1. Door
2. Pull-out
3. Sliding door
4. Frame
B. Driving lights
1. Split-rim retainer
2. Solid-rim retainer
C. Tail and stop lights
1. Door
2. Doorless
3. Split-ring
4. Retaining-ring
5. Screw-mounted-lens
6. Pull-out
D. License plate lights
1. Snap-in
2. Bayonet
3. Pull-out
4. Bumper
5. Recess
6. Cap
E. Interior lights
1. Pillar
2. Spring
3. Snap-on
4. Screw-on

III. Headlight aiming
A. Mechanical
B. Optical
C. Wall-chart
D. Vertical adjustments
E. Horizontal adjustments
F. Problems encountered due to uneven loading or faulty springs

IV. Typical lighting problems and causes
A. Short-bulb life
B. Dim lights
C. Flickering lights
D. Out of adjustment
E. Headlight switch replacement
F. Dimmer switch replacement
G. Flare-up or acceleration

V. Circuit protection
A. Need for fuses
1. Types of fuses
B. Function and need of circuit breaker

VI. Turning signals
A. Description of operation
B. Types of circuits
C. Importance of bulb size and type
D. Turn signal flasher
E. Cancelling devices

LABORATORY ACTIVITY

I. Demonstrate how to remove and replace headlights
II. Demonstrate the use of the headlight aimer
III. Demonstrate how to test a light bulb
IV. Demonstrate how to test a fuse (continuity)

SHOP ACTIVITY

I. Remove various bulbs
II. Adjust headlights on an automobile
III. Locate fuse panel or circuit breaker on automobiles
IV. Locate directional signal flasher on automobiles
V. Locate stop-light switch

Unit 11. AUTOMATIC TRANSMISSION MINOR SERVICE

THIS SECTION can be divided into two classifications. The maintenance classification will include checking and adding fluid and the draining and refilling of the transmission. The adjustment classification is simply the relationship of the carburetor throttle valve to the transmission throttle lever. Some of the complaints pertaining to poor transmission operation are as follows:

I. Late or early shifting
II. Harsh shifting
III. Skip shifting

Very often, a simple external adjustment of the linkage will solve the problem. The purpose of this unit is to have the trainees understand and perform these simple adjustments.

TIME ALLOCATION

Classroom, 5 hours; laboratory, 35 hours; shop, 10 hours

TOOLS AND MATERIALS

I. Transmission tool kit

II. Transmission specification manuals

TEACHING GUIDE

After discussing the transmission fundamentals with the trainees, acquaint them with the various automatic transmissions by listing the names of the transmissions and the major car manufacturers that use them. Also, explain the various types of shifting patterns as they pertain to individual transmissions. Adjust the linkage on as many types of transmissions as possible, pointing out the different procedures and cautions.

DISCUSSION TOPICS

I. Transmission fundamentals—function and operating characteristics of:
   - A. The planetary gear set
   - B. A fluid coupling
   - C. A torque converter
   - D. Control valves and servo-mechanisms

II. Maintenance and adjustment requirements
   - A. Fluid level requirements
     1. Check type used
     2. Check and add fluid
     3. Drain and refill
   - B. Emergency starting procedures
   - *C. Linkage and switch adjustment
     1. Neutral safety switch
     2. Throttle linkage
     3. Gear shift control linkage
     4. Anti-stall dashpot clearance

*Use manufacturer's recommended adjustments and procedures on each individual type of transmission.

LABORATORY PROCEDURE

I. Drive different automobiles equipped with different automatic transmissions to become familiar with the various shift patterns

II. Adjust the linkage on those transmissions found to be shifting imperfectly

III. Adjust the neutral safety switch on various automobiles

IV. Check the fluid level on all transmissions available and adjust this level as per manufacturers' specifications

V. Locate transmission fluid leaks

Unit 12. TIRE SERVICE

AUTOMOBILE OWNERS EXPECT servicemen to provide some type of tire service in their business. This service should include periodic tire inspection, tire rotation, the repairing of damaged tires, and the sale of new tires. This unit is designed to offer the trainees an understanding of tire service demanded by the motoring public.

TIME ALLOCATION

Classroom, 2 hours; laboratory, 4 hours; shop, 14 hours

TOOLS AND MATERIALS

I. Four tubeless tires (mounted on rims)
II. Four tube-type tires (mounted on rims)
III. Tire-changing equipment
IV. Tire-repair kit
V. Several air valves
VI. Bench vulcanizer
VII. Water tank

TEACHING GUIDE

After discussing the following topics, demonstrate the various methods of demounting and mounting of tires and the techniques involved in repairing damaged tires. Trainees should change tires, service tires, and rotate tires until they achieve sufficient skill to perform this service commercially.

DISCUSSION TOPICS

I. Tire construction
  A. Materials used
  B. Tire terminology
    1. Bead
    2. Chafing strip
    3. Reinforcing strip
    4. Plies
    5. Sidewall
    6. Tread
  C. Tire markings
    1. Tire-size markings
    2. Ply markings
    3. Balance marks
II. Tire care and service
  A. Effects of inflation
    1. Over inflation
    2. Under inflation
  B. Tire rotation plans
    1. Four-tire system
    2. Five-tire system
  C. Effects of front-end alignment on tire wear
  D. Effects of wheel balance on tire wear
  E. Types of casing injuries
    1. Rim injuries
    2. Impact injuries
    3. Inflation injuries
    4. Tread wear
      a. Driving habits
      b. Mechanical problems
      c. Road conditions
    5. Tire-cut damage

LABORATORY ACTIVITY

I. Demonstrate demounting and mounting procedures on tires with tubes
II. Demonstrate demounting and mounting procedures on tubeless tires
III. Demonstrate tire repair methods
  A. Tubeless tire
    1. Rubber plug repair
    2. "Tire dough" repair
    3. Cold patch repair
    4. Hot patch repair
  B. Tube repair
    1. Cold patch repair
    2. Hot patch repair
  C. Installation of air valves

SHOP ACTIVITY

I. Demount and mount tube-type tire
II. Demount and mount tubeless tire
III. Patch a tube using cold and hot repair methods
IV. Repair a tubeless tire using various methods
V. Rotate tires on an automobile
VI. Inspect condition of tires on several automobiles

Unit 13. MINOR BRAKE-ADJUSTMENT PROCEDURES

MODERN HIGHWAYS, more powerful and faster-moving automobiles, and improved wheel and tire design are all major factors that have contributed to the need for improving the automobile braking system.

Many of these improvements were of a technical nature, thus making minor brake adjustments vitally important to highway and vehicle-owner safety. This unit is designed to introduce brake-adjustment procedures to the trainees.

TIME ALLOCATION

Classroom, 3 hours; laboratory, 14 hours; shop, 28 hours

TOOLS AND MATERIALS

I. Brake service tool kit
II. Hydraulic fluid dispenser
III. Wheel puller
IV. Hand tool kit

TEACHING GUIDE

Typical brake systems used by the various automobile manufacturers could be displayed in the shop area in order to correlate the discussion topics and actual system operation.

DISCUSSION TOPICS

I. Basic brake-operating principles
  A. Basic operating principle of the servo and non-servo brakes
  B. Basic operating principles of the hand brake
II. Components of the hydraulic brake system
III. Brake-adjustment procedures
  A. Preliminary checks
    1. Pedal check
      a. Pedal height and free travel
      b. Solid or spongy "feel"
    2. Condition of hydraulic lines
    3. Condition of brake lining
    4. Condition of "U" bolts
    5. Condition of shock absorbers
    6. Condition of rubber bushings and ball joints
    7. Fluid level in master cylinder
  B. Basic brake-adjustment information
    1. Explanation of manually adjusted systems
    2. Explanation of self-adjusting systems
  C. Minor brake adjustment—non-servo brakes
    1. Review of Lockheed fixed anchor type
      a. Method of adjustment
      b. Adjustment procedure
    2. Review of Huck brake
      a. Method of adjustment
      b. Adjustment procedure
    3. Wagner self-centering brake
      a. Method of adjustment
      b. Adjustment procedure
    4. Wagner self-centering with self-adjusters
      a. Description of self-adjuster operation
      b. Service procedure for non-functioning self-adjusters
    5. Center plane, total contact brakes
      a. Method of adjustment
      b. Adjustment procedures
    6. Bendix self-centering brakes
      a. Method of adjustment
      b. Adjustment procedures
  D. Minor brake adjustment—servo-type brakes
    1. Bendix duo servo brake
      a. Method of adjustment
      b. Adjustment procedures
    2. Bendix self-adjusting brakes
      a. Method of adjustment
      b. Adjustment procedures
    3. Wagner self-centering, self-energizing brake
      a. Method of adjustment
      b. Adjustment procedures
    4. Wagner self-centering, self-adjusting brake
      a. Method of adjustment
      b. Adjustment procedure

LABORATORY ACTIVITY

I. Demonstrate the inspection procedure prior to making a brake adjustment
II. Demonstrate the minor brake adjustment on different types of brake systems
III. Demonstrate the method of adjusting various hand brake systems

SHOP ACTIVITY

I. Inspect an automotive brake system for safety and service needs
II. Perform minor adjustments on several different types of brake systems
III. Adjust several different types of hand brakes

Unit 14. AUTOMOBILE CLEANING SERVICE

THE APPEARANCE of the automobile when delivered to a customer could well be the deciding factor for repeat business. People enjoy driving a clean automobile, one that is not only clean on the outside but clean on the inside as well. Automobile owners are even taking a greater pride in the appearance of the engine compartment, which at one time was considered normal in appearance if it was dirty and greasy. To establish a quality level in cleaning service, assume that each car delivered from a service center is to be delivered to the woman in white—white hat, white shoes, white dress, and white gloves. This unit is designed to offer the trainees the opportunity to learn how to render such service. This will include washing and waxing the exterior finish, cleaning the automobile interior, and cleaning the automobile engine compartment.

TIME ALLOCATION

Classroom, 1 hour; shop, 28 hours

TOOLS AND MATERIALS

I. Wash pail, mitt, and tire brush
II. Chamois
III. Car-wash soap
IV. Engine-cleaning gun
V. Engine-cleaning chemical
VI. Vacuum cleaner

TEACHING GUIDE

Discuss the following cleaning procedures. Trainees should then clean their own automobiles following these procedures. Demonstrate the engine-cleaning operation. Require trainees to clean the engine compartments of their own cars.

DISCUSSION TOPICS

I. Cleaning the interior
  A. Vacuum the front and rear seats
  B. Vacuum the front and rear floor coverings
  C. Clean the ashtrays
  D. Dust the dashboard and steering column
  E. Vacuum the trunk compartment
II. Cleaning the exterior
  A. Close all windows and vents
  B. Wash car
    1. Include flushing the underside of the fenders
    2. Wipe off dirt around the door openings and sills
    3. Wipe all windows inside and out
    4. Wipe all chrome trim
III. Cleaning the engine compartment
  A. Protect front fenders
  B. Cover carburetor
  C. Clean under hood compartment
    1. Underside of hood
    2. Firewall and fender housings
    3. Engine
  D. Probable starting problems after cleaning

SHOP ACTIVITY

I. Clean automobile interior
II. Clean automobile exterior
III. Clean engine compartment

Unit 15. LUBRICATION AND PREVENTIVE MAINTENANCE PROCEDURE

LUBRICATION REQUIREMENTS on the automobile have changed in recent years. Even though the time interval between lubrication jobs has increased and the number of fittings needing lubrication have been reduced, the automobile still needs periodic lubrication service. This service can be divided into four areas: Engine, transmission, chassis, and body. The purpose of this unit is to offer instruction on the automobile lubrication and preventive maintenance requirements in these four areas. Use of the standard lubrication guide should be stressed throughout this unit.

TIME ALLOCATION

Classroom, 2 hours; laboratory, 5 hours; shop, 105 hours

TOOLS AND MATERIALS

I. High pressure lubrication gun
II. Lubrication hand gun
III. Screw-on and rubber-tipped low-pressure adapters
IV. Assortment of fittings
V. Lubrication guide
VI. Tire air-pressure gauge
VII. Powdered graphite dispenser
VIII. Transmission fluid dispenser

SHOP SAFETY PROCEDURES

I. Hydraulic lift instructions
  A. Never stand in front of car while guiding it on to lift
  B. With frame contact lifts, be sure lifting pads are properly placed on frame of car
  C. Be sure passengers are out of car when elevating car on hoist
  D. Check the lift safety device to be sure it is in working order and that it engages when the lift is raised

TEACHING GUIDE

Discuss the following topics pointing out the various applications for each item such as oil filter systems and types. Apply this information by demonstrating a complete lubrication and preventive maintenance service on an automobile. Trainees should practice lubricating and inspecting various automobiles.

DISCUSSION TOPICS

I. Special lubrication equipment—need and application
  A. Assorted fittings
  B. Low-pressure adapters
  C. Hand guns
  D. Ball-joint adapters
II. Lubrication needs of the engine
  A. Engine oil change
  B. Filter change
  C. Lubricate distributor, generator and starter
  D. Clean fuel filters
  E. Service air cleaner
  F. Service oil filter breather cap and crankcase breather filter
  G. Service positive crankcase ventiliation system and valve
  H. Adjust accessory drive belts
  I. Check and correct cooling system liquid level
  J. Service manifold heat control valve
III. Transmission lubrication needs
  A. Check oil level
    1. Standard transmission
    2. Automatic transmission
  B. Changing or correcting fluid levels

IV. Chassis lubrication needs
  A. Check and correct powersteering reservoir fluid level
  B. Check and correct brake master cylinder fluid level
  C. Check and correct differential fluid level
  D. Lubricate ball joints
  E. Lubricate steering linkage
  F. Lubricate universal joints
  G. Check and correct battery electrolyte level
  H. Check tire air pressure
  I. Check condition of brake lines
  J. Service power brake filter
  K. Refill windshield washer reservoir
V. Body lubrication needs
  A. Lubricate hood latch
  B. Lubricate lock cylinder
  C. Lubricate tailgate hinges and supports
  D. Lubricate fuel filter door hinges
  E. Lubricate door hinges
  F. Lubricate door latch and striker plates
  G. Lubricate luggage compartment hinge pivots
  H. Lubricate hood hinge pivots
  I. Check windshield wiper blades
  J. Check and open body drain holes
  K. Lubricate front seat rails
VI. Use of the lubrication guide
  A. Individual lubrication requirements of different models of automobiles
  B. Types of lubricants needed
VII. How to sell lubrication service to customer
VIII. How to sell preventative maintenance service

LABORATORY ACTIVITY

I. Demonstrate the complete lubrication of a vehicle following procedures outlined in the lubrication guide

II. Demonstrate the use of specilized equipment and equipment adapters

SHOP ACTIVITY

I. Lubricate several automobiles, including the following activities
  A. Change oil and filters
  B. Lubricate chassis
  C. Lubricate engine components
  D. Lubricate body
  E. Change automatic transmission fluid

II. Check and fill ball joints as per manufacturers' directions

III. Perform preventative maintenance checks and procedures, and correct malfunctions as necessary

Section II.
ELECTRICAL AND FUEL SERVICE

ELEMENTS OF ENGINE TUNE-UP

Instructional Unit	Number of hours in—		
	Classroom	Laboratory	Shop
1. Introduction to the Automobile Electrical System	2	0	2
2. Introduction to Basic Instruments	4	4	0
3. Storage Batteries	4	2	4
4. The Ignition Circuit	8	6	10
5. A.C. Generators	3	6	4
6. A.C. Charging Circuit Controls	4	6	6
7. D.C. Generators	3	6	4
8. D.C. Charging Circuit Controls	4	6	3
9. Starters and Starter Drives	3	8	6
Total	35	44	39

Before an automotive service specialist can diagnose an engine malfunction and tune up an engine he must know the basic elements of construction and operation of the electrical components. This unit will provide the information necessary for a trainee to study proper tune up and service procedure; provide some experience in disassembly and reassembly of electrical components; and the bench tests needed to determine the serviceability of the components.

Attention is also directed to merchandising, work safety, and speed, all of which should be stressed constantly and realistically. The trainee should develop the concept that knowledge of safety procedures is vital to himself, his employer, and the unit he is working on. A concept of time in relation to profit is essential. An increase in speed in completing a job may mean an increase in volume of work, and this in turn may reflect a more thriving business. Trainees should be made to realize that speed, quality, and thoroughness are equally important in developing efficient work habits.

Unit 1. INTRODUCTION TO THE AUTOMOBILE ELECTRICAL SYSTEM

THE PURPOSE OF THIS UNIT is to introduce the automobile electrical systems to the trainee. To provide for ease of instruction, the electrical system of the automobile will be divided into four basic circuits. Each of these basic circuits will be studied with reference to the general purpose of the circuit, the indentification of component parts that make up the circuit, and relationship of one circuit to another as they function together in the automobile.

TIME ALLOCATION

Classroom, 2 hours; shop, 2 hours

TEACHING GUIDE

Discuss the four circuits as to purpose, component parts, and general over-all function. Shop time should be spent locating the various circuits on different automobiles.

DISCUSSION TOPICS

I. Introduction to the basic circuits
   A. Charging circuit
   B. Cranking circuit
   C. Ignition circuit
   D. Lighting and accessory circuit

II. Descriptive definition and purpose of each circuit
   A. Charging cicuit
      1. This circuit, including the battery, supplies all of the electrical power for the entire automobile; therefore, the other circuits are dependent on it for their operation.
   B. Cranking circuit
      1. This circuit cranks the engine and is of vital importance in starting.
   C. Ignition circuit
      1. When the engine is cranked and fuel is present, this circuit enables the engine to start and operate continuously by delivering the series of precisely timed sparks that ignite the compressed air fuel mixture in the combustion chamber.
   D. Lighting and accessory circuit
      1. This circuit delivers electric power to operate the safety and convenience electrical devices of the automobile, such as lights, horns, accessories, and dash instruments.

III. Components of each circuit
   A. Charging circuit
      1. Battery
      2. Generator
         a. A type
         b. B type
         c. D.C. type
         d. A.C. type
      3. Regulator or control device
   B. Cranking circuit
      1. Battery
      2. Switch or control
         a. Neutral safety switch
         b. Solenoid
         c. Magnetic switch
         d. Mechanical switch
      3. Starter motor
      4. Connecting cables
   C. Ignition system
      1. Primary circuit
         a. Battery
         b. Primary winding of coil
         c. Ignition contact points
         d. Grounds
         e. Condenser
         f. Connecting wires
      2. Secondary circuit
         a. Secondary winding of coil
         b. Rotor
         c. Cap
         d. Plugs
         e. Grounds
         f. Secondary wires
   D. Lighting and accessory systems
      1. Safety group
         a. Horns
         b. Lights
         c. Turn signals
         d. Relays and switches
         e. Windshield wipers
      2. Convenience group
         a. Radio
         b. Heaters
         c. Seats
         d. Tops
         e. Window lifts
         f. Air conditioners
         g. Cigarette lighters

SHOP ACTIVITY

I. Locate and trace the basic electrical circuits in the automobile. Have the trainee draw each circuit on paper as he traces the actual circuit on an automobile. Compare the trainees' sketches with the manufacturers' schematic diagrams.

II. Point out the importance of the fuse panel as a central "electrical nerve center." Explain that trouble involving burned fuses in any individual circuit would be traced from this nerve center.

Unit 2. INTRODUCTION TO BASIC INSTRUMENTS

MODERN ELECTRICAL ANALYSIS cannot be done properly without the use of instruments. The voltmeter and the ammeter are basic instruments that give maximum information and should be studied first. It is important that meter principle and operation be studied so trainees will understand what they are doing with the instruments.

TIME ALLOCATION

Classroom, 4 hours; laboratory, 4 hours

TOOLS AND MATERIALS

I. A high rate discharge tester to include an ammeter, carbon pile, and voltmeter
II. A multiple-scale voltmeter: Range, 0–40 volts
III. An ammeter: Range, 0–600 amps
IV. A light-load tester or voltmeter that will read in increments of one-hundredth of a volt: Range, 0–3 volts

TEACHING GUIDE

Discuss the various classroom topics stressing the simplicity of meter operation and instrumentation. Keep the meters available while talking about them. Make as many references to meter use as possible when discussing them. Have trainees measure battery voltage, cell voltage, cable voltage drop, current flow through the coil circuit, and any other circuit checks that will enable them to use the meters throughout their maximum range.

DISCUSSION TOPICS

I. Voltmeter
  A. Purpose of the meter
  B. Function of the meter
  C. How to read a single-scale meter
  D. How to read a multiple-scale meter
  E. How damage can occur to a meter
II. Ammeter
  A. Purpose of the meter
  B. Function of the meter
  C. How to read a single-scale meter
  D. How to read a multiple-scale meter
  E. How the ammeter is used in conjunction with a carbon pile
  F. Explain the possibility of meter damage when connected across the battery with no load in the circuit
III. Care and use of meters
  A. Explain the importance of handling meters with care
    1. The mechanical accuracy of meters
    2. The importance of cable or lead condition to meter accuracy
  B. Explain the term "total voltage."
  C. Explain the term "voltage drop."

LABORATORY ACTIVITY

I. Have trainees measure voltage and current requirements of some common circuits in order to understand the hookups and read the meter results. For example, trainees could test:
  A. Individual cell voltage
  B. Battery voltage
  C. Starter amperage draw
  D. Cranking voltage
  E. Coil current draw
  F. Charging voltage (across the battery)
  G. Charging output amps (suggestion: Use a battery-cable post adapter for this test)

Unit 3. STORAGE BATTERIES

BATTERIES HAVE ALWAYS BEEN a problem in the service industry, primarily because those who are to service them do not really understand how they function. Battery failures, other than from old-age,

are generally caused by some malfunction within the electrical system. When the cause of a battery failure is determined, additional merchandising becomes possible. The cause of the failure should be determined and corrected so that the customer will get maximum service from his battery. In order to render this service, trainees must understand how batteries are constructed and how they function. They must also study the types of problems that cause batteries to fail and how to test for these failures and interpret the results.

TIME ALLOCATION

Classroom, 4 hours; laboratory, 2 hours; shop, 4 hours

TOOLS AND MATERIALS

I. Several batteries (good and bad)
II. Light-load tester
III. High-rate discharge tester
IV. Hydrometer
V. Battery charger

TEACHING GUIDE

Discuss classroom topics in detail. Demonstrate the testing of batteries in the laboratory as you teach the tests. Have trainees perform battery tests in the laboratory and assist them with the sequence of testing and interpreting the results. Trainees should then test several batteries in automobiles.

Be sure to caution trainees about battery hazards before working on them. The battery is highly explosive under given conditions. Emphasize that the more experience the trainees have the better they will be able to interpret test results.

DISCUSSION TOPICS

I. Battery components and construction
  A. Plates
  B. Electrolyte solution
  C. Separators
  D. Case and caps
II. How the battery works
  A. Chemical action in the battery
    1. Charging action
    2. Discharging action
  B. Significance of specific gravity
  C. Effects of voltage and state of charge on charging rates
III. Causes of battery failures
  A. Faulty charging system
    1. Overcharging
    2. Undercharging
  B. Types of driving conditions
  C. Electrical troubles
    1. Causing excessive drain on battery
    2. Causing excessive use of starter
  D. Low water levels
  E. Old-age factors
  F. Sulphation
IV. Battery maintenance and storage
  A. Storage problems
    1. Wet-type battery
    2. Dry-type battery
  B. Stock rotation
    1. Selling oldest batteries first
  C. Continual maintenance program to keep batteries in salable condition
  D. Battery charging
    1. Trickle charge
    2. Slow charging
    3. Fast charging—boost charging
V. Merchandising batteries

LABORATORY ACTIVITY

I. Demonstrations to be performed
  A. Visual inspection of batteries
    1. Point out items of concern, such as cracks, dirty conditions, cap vent holes, distorted case, and corroded terminals
  B. Use of hydrometer
    1. Principle of operation
    2. How to use the hydrometer
    3. How to interpret test results
    4. How to compensate for temperature
    5. How to clean a hydrometer

C. Use of high-rate discharge tester
D. Use of battery chargers
   1. Fast and slow charging
   2. Series and parallel charging
   3. Jumper connections
E. How to test for sulphation
   1. 3-minute test procedure
F. Light-load testing procedure

SHOP ACTIVITY

I. Determine polarity of a battery with voltmeter
II. Perform light load battery test
III. Perform high-rate discharge test
IV. Perform sulphation test
V. Boost charge batteries
VI. Clean battery case and battery carrier
VII. Clean battery posts and cable connectors
VIII. Fill batteries to proper electrolyte level

Unit 4. IGNITION CIRCUIT

BEFORE THE TRAINEE LEARNS to test and diagnose problems in the ignition circuit, he should first study the function, construction, and operation of the components that make up the system. This is the objective of this unit. The operational effects of one component on other components should be stressed. This unit will provide the necessary theory and application which should precede diagnostic work.

TIME ALLOCATION

Classroom, 8 hours; laboratory, 6 hours; shop, 10 hours

TOOLS AND MATERIALS

I. Set of ignition contact points
II. Condenser
III. Cutaway coil
IV. Variety of distributors
V. Spark plugs of various types and heat ranges
VI. Distributor caps and rotors
VII. Samples of secondary wire

NOTE: If examples of both good and bad units can be found, a more effective demonstration will result.

TEACHING GUIDE

The inclusion of a considerable amount of classroom material in this unit makes it advisable to break the unit into several sections so trainees can work in laboratory sessions or shop sessions at various stages in the series. Be sure trainees fully understand each phase of the ignition circuit as well as the function of all the components. This is an extremely important prerequisite to the diagnostic work the trainees will be doing later in the program.

DISCUSSION TOPICS

I. Function of the ignition circuit
   A. Primary circuit
   B. Secondary circuit
II. Components of the primary circuit
   A. Battery
   B. Ammeter
   C. Ignition switch
   D. Primary coil winding
   E. Contact points
   F. Condenser
   G. Ground wires
   H. Primary wiring harness
III. Components of the secondary circuit
   A. Secondary coil windings
   B. Distributor cap and rotor
   C. Spark plugs
   D. Secondary wiring harness
IV. Function, construction, and operation of primary units
   A. Coil
   B. Contact points
      1. Explanation of point dwell

2. Relationship of point gap to point dwell angle
3. Relationship of point dwell to ignition timing
4. Point geometry

C. Condenser

V. Function, construction, and operation of secondary units
A. Coil
B. Distributor cap and rotor
C. Secondary wire
1. Resistor wire vs. copper wire
2. Effects of copper wire when used with distributor caps with aluminum tower inserts
D. Spark plugs
1. Heat ranges
2. Conversion charts

VI. Distributor: Construction and operation
A. Single and dual contact set installations
B. Mechanical advance
C. Vacuum advance
D. Combined mechanical and vacuum advance
E. Vacuum-controlled single advance
F. Distributor timing
1. Manufacturer's recommendation
2. Allowable limits
G. Effect of distributor wear on ignition timing
1. Contact set rubbing block
2. Breaker cam
3. Breaker plate
4. Bushings
H. Distributor lubrication
1. Contact points rubbing block and pivot
2. Breaker cam
3. Breaker plate
4. Bushings
5. Advance mechanism
I. Factors affecting contact point life
1. Condenser
2. Charging circuits
3. Idling and low-speed operation
4. Moisture
5. Overlubrication
6. Misalignment
7. Careless installation

LABORATORY ACTIVITIES

I. Replace a set of contacts and a condenser
II. Lubricate distributor
III. Remove, test, and replace breaker plate
IV. Disassemble distributor completely
A. Check shaft and bushing wear
B. Check mechanical advance mechanism
C. Check vacuum advance diaphram

SHOP ACTIVITY

I. Remove distributor and crank engine
II. Replace distributor in engine properly timed
III. Time engine using timing light
IV. Check advance operation with timing light
V. Trace ignition circuit on different systems
A. General Motors
B. Ford
C. Chrysler
D. American Motors
VI. Remove all secondary wires and rewire engine to firing order specifications
VII. Remove and replace distributor contact points and condenser without removing the distributor from the engine
VIII. Check the location of primary ballast
A. Check wire type
B. Check resistor-unit type

Unit 5. A.C. GENERATORS

THE PURPOSE OF A GENERATOR, either D.C. or A.C., is to provide a source of electrical energy for the automobile which will maintain the storage battery in a fully charged condition and to supply a sufficient amount of current to meet the electrical load requirements of the automobile. This unit will introduce the A.C. generator to the trainee. It will include the types and designs, operating principles, adjustments, tests, and maintenance of the A.C. generator.

TIME ALLOCATION

Classroom, 3 hours; laboratory, 6 hours; shop, 4 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. A.C. generator special tool kit
III. Ohmmeter—1½-volt cell
IV. Various diodes—good and bad
V. Various A.C. generators—Ford, Delco-Remy, Chrysler, Leece-Neville
VI. 110-volt test lamp
VII. Polishing paper—400-grain or finer

TEACHING GUIDE

Discuss the following topics relating to A.C. generators, stressing the terminology differences between A.C. and D.C. generators. Whenever possible use the A.C. generator with the discussions. Demonstrate the disassembly, testing, servicing, and reassembly of the A.C. generator and require the trainees to test several generators as a laboratory exercise.

DISCUSSION TOPICS

I. Generator nomenclature
  A. Brush assembly
  B. Rotor segments
  C. Stator assembly
  D. Slip rings
  E. Fan and pulley assembly
  F. Bearings
  G. End frame assemblies
II. Principles of operation
  A. Magnetic principles
  B. Development of single-phase sine wave
  C. Development of three-phase sine wave
  D. Principles of rectification
    1. Rectifiers
    2. Diodes
III. Types of circuits
  A. "Y" type
  B. Delta type
IV. Bench testing the generator
  A. Rotor testing
    1. Shorts
    2. Grounds
    3. Opens
  B. Stator testing
    1. Shorts
    2. Grounds
    3. Opens
  C. Case testing
    1. Inspect and test for grounded terminals
    2. Inspect and test for grounded heat sink
  D. Diode testing
  E. Check brush holders and brush-spring tension

LABORATORY ACTIVITY

I. Demonstrate use of special tools required for disassembly and reassembly of the A.C. generator
II. Perform a complete bench test on an A.C. generator
III. Demonstrate the proper procedure for testing and replacing diodes
IV. Demonstrate the service procedure for cleaning the slip rings on rotor
V. Demonstrate the method of connecting battery charger to the battery
VI. Demonstrate the method of connecting jumper cables

SHOP ACTIVITY

I. Remove generator from the automobile
II. Disassemble, clean, and bench-test the generator
III. Service the slip rings on the rotor
IV. Reassemble, install, and test the generator
V. Lubricate the generator

Unit 6. A.C. CHARGING CIRCUIT CONTROLS

ALL GENERATORS have some external type of regulation. In order to be able to diagnose charging circuit trouble, trainees must understand the type of regulation used. The purpose of this unit is to acquaint the trainees with the various types of control devices. Minor voltage adjustments should be stressed in the practice session.

TIME ALLOCATION

Classroom, 4 hours; laboratory, 6 hours; shop, 6 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Ohmmeter
III. Voltmeter
IV. Ammeter
V. 100-volt test lamp
VI. Carbon pile rheostat
VII. Jumper wire—6-inch
VIII. Chrysler regulator
IX. Delco regulator
  A. Two-unit
  B. Three-unit
  C. Transistorized
X. Ford regulator
XI. Leece-Neville regulator

TEACHING GUIDE

After completing the topics for discussion in the classroom, the trainees will trace the circuits through the several types of regulators. They should learn to make minor adjustments to these types of regulators in the laboratory. The shop work should be devoted to testing of the A.C. charging circuits.

DISCUSSION TOPICS

I. Regulator classification
  A. Electro-magnetic
    1. Single-unit regulator
    2. Two-unit regulator
    3. Three-unit regulator
  B. Transistor
    1. Transistorized regulators
    2. Transistor regulators
II. Principles of regulator operation
  A. Single-contact voltage control
  B. Double-contact voltage control
  C. Circuit-breaker relay
  D. Control relays
  E. Transistorized regulation
  F. Transistor regulation
III. Components of typical A.C. charging circuits
  A. Delco-Remy circuits
  B. Chrysler circuit
  C. Leece-Neville circuit
  D. Ford circuit
  E. Motorola circuit
IV. Analyzing charging system malfunctions
  A. Full-charged battery—high-charge rate
  B. Low-charged battery—low-charge rate
  C. Low-charged battery—no charge rate
  D. Excessive arcing at the regulator contact points
V. Electrical checks and adjustments
  A. Importance of regulator voltage adjustment and regulator ambient temperature
  B. Circuit-resistance tests
  C. Generator output test
  D. Voltage control tests and adjustments
  E. Tailoring voltage regulator settings to battery state of charge

LABORATORY ACTIVITY

I. Demonstrate methods of adjustment on various voltage controls
II. Test for circuit resistance
III. Test for generator output
IV. Test the voltage-control settings
V. Demonstrate minor regulator adjustments
VI. Test load-relay operation

SHOP ACTIVITY

I. Test Chrysler charging circuit
  A. Circuit resistance
  B. Generator output
  C. Voltage regulator setting
II. Test Delco-Remy charging circuit
  A. Load-relay operation
  B. Circuit resistance
  C. Generator output
  D. Voltage-regulator setting
III. Test Ford charging circuit
  A. Load-relay operation
  B. Circuit resistance
  C. Generator output
  D. Voltage-regulator setting

Unit 7. D.C. GENERATORS

THE PURPOSE of this unit is to explain the nomenclature and function of the generator. The generator is a major part of the charging circuit and provides for the electrical needs of the automobile. Special emphasis should be placed on the differences between the A- and B-type circuits.

TIME ALLOCATION

Classroom, 3 hours; laboratory, 6 hours; shop, 4 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. A-type generator
III. B-type generator
IV. Growler with test light

TEACHING GUIDE

Discuss the following topics, stressing the differences between the A- and B-type circuits. Whenever possible use the generator with the discussion. Demonstrate the disassembly, testing, and reassembly. Require the trainees to test several generators as a laboratory exercise.

DISCUSSION TOPICS

I. Generator components
  A. Brush and brush-holder assembly
  B. Commutator
  C. Armature
  D. Pole shoes
  E. Field coils
  F. Bearings
  G. End-frame assemblies
  H. Pulley (sizes)
II. Principles of generator operation
  A. Magnetic principles
  B. Brush and commutator action
III. Types of circuits
  A. A-type generator
  B. B-type generator
IV. Bench testing the generator
  A. Field testing
    1. Test for shorts
    2. Test for grounds
    3. Test for opens
  B. Armature testing
    1. Test for shorts
    2. Test for grounds
    3. Test for opens
  C. Case inspection and testing
    1. Inspect and test for grounded terminals
    2. Inspect and test brush-holder assemblies
  D. Field balance test

LABORATORY ACTIVITY

I. Perform a complete bench test on an A-type generator
II. Perform a complete bench test on a B-type generator
III. Trace the field circuit on an A-type and B-type generator
IV. Remove and replace brushes
V. Explain the procedure for removing and replacing generator bushings and bearings
VI. Clean commutator with commutator sandpaper
VII. Turn and undercut commutator
VIII. Seat generator brushes after installing

SHOP ACTIVITY

I. Remove generator from automobile
II. Bench test generator
III. Clean generator
IV. Service generator armature
    A. Using commutator paper
    B. Turning and undercutting the commutator
V. Reassemble, test, and install generator on automobile
VI. Lubricate generator

Unit 8. D.C. CHARGING CIRCUIT CONTROLS

THE PURPOSE OF THIS UINT is to acquaint the trainees with the three-unit regulator. Special emphasis should be placed on the importance of the regulator in the charging circuit as a limiting unit. Damage resulting from reverse polarity, arcing brushes, shorted field coils, and grounded connecting wires should be explained. Emphasis should be placed on the necessity of checking this unit whenever charging-circuit malfunctions occur in the automobile.

TIME ALLOCATION

Classroom, 4 hours; laboratory, 6 hours; shop, 3 hours

TOOLS AND MATERIALS

I. Several regulators of the types currently in use
II. Hand tool kit
III. Regulator service kit
IV. Voltmeter
V. Jumper wire
VI. Lintless tape and cleaning solvent

TEACHING GUIDE

After completing the topics for discussion in the classroom, the trainees should trace the circuits through the different types of regulators. They should then perform minor adjustments to the unit in the laboratory. In the shop the trainees should make tests on both A-type generator systems and B-type generator circuits. If the circuit is inoperative, the tests will determine whether the generator or the regulator is at fault.

DISCUSSION TOPICS

I. Regulation or limiting action of the charging circuit
    A. Function of the cutout relay
    B. Function of the current limiter
    C. Function of the voltage limiter
        1. Single contact
        2. Double contact
II. Location and purpose of relay
    A. Cutout relay
    B. Current limiter
    C. Voltage limiter
III. Effect of temperature on regulation
IV. Application of charging-circuit voltage potential as it applies to charging the battery
V. Adjustments and cautions pertaining to regulator service
    A. Cutout relay
        1. Opening current
        2. Closing voltage
    B. Current limiter
    C. Voltage limiter
    D. Air-gap adjustments
VI. Adjusting the circuit to customer driving habits
VII. Regulator specifications
    A. Where to locate specifications
    B. General specifications vs. complete temperature effect charts

LABORATORY ACTIVITY

I. Trace current control circuit from generator through the regulator
II. Trace voltage control circuit from generator through the regulator
III. Make air-gap adjustment on regulator
IV. Clean contacts on regulator

SHOP ACTIVITY

I. The following procedure is to be used on a circuit with a complete failure to determine if the generator or regulator is defective. This trouble-shooting test may be used on A-type or B-type circuits.
   A. A-type generator circuit
      1. Disconnect field and armature wire from regulator
      2. Connect voltmeter from ground to armature wire disconnected from regulator
      3. Start engine
      4. Ground field wire
      5. If the voltmeter registers battery voltage or above, the regulator is at fault
      6. If voltage is less than normal battery voltage, the generator is at fault

CAUTION: Do Not Exceed Maximum Allowable Voltage

   B. B-type generator circuit
      1. Disconnect field and armature wire from regulator wires from A and F terminals from the regulator
      2. Connect wires from A terminal and F terminal
      3. Connect voltmeter from this junction to ground
      4. Start engine
      5. If the voltmeter registers battery voltage or more, the regulator is at fault
      6. If voltage is less than normal battery voltage, the generator is at fault

CAUTION: Do Not Exceed Maximum Allowable Voltage

II. Check brush condition on several vehicles
III. Clean commutator when possible without removing generator from vehicle
IV. Perform minor voltage limiter adjustment in regulator
V. Perform minor current limiter adjustment in regulator
VI. Check condition of all contact points in regulator

Unit 9. STARTER AND STARTER DRIVES

MANY TIMES STARTER TROUBLES can be easily and simply repaired if the serviceman knows how the mechanism works and how to locate the malfunction. This unit will introduce starter terminology, principles of operation, types of starter circuits, types of starter drives, general service problems, and bench-test service procedures.

TIME ALLOCATION

Classroom, 3 hours; laboratory, 8 hours; shop, 6 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Growler with test light
III. Various types of starters
   A. Ford Falcon type
   B. Chrysler (gear reduction type)
   C. General Motors type
IV. Bendix drive mechanism
V. Overrunning clutch mechanism
VI. Typical solenoid
VII. 12-volt storage battery
VIII. Jumper wires—12 inches long
IX. Ammeter: Range, 0–600 amps
X. R. P. M. indicator gauge

TEACHING GUIDE

Discuss the principles of operation for each of the components of a typical starter. Following this discussion, trainees should disassemble various starters for inspection. Demonstrate the techniques involved for replacing starter drives. Demonstrate the bench tests to determine whether or not the starter is serviceable.

DISCUSSION TOPICS

I. Purpose of the starter
II. Magnetic principles as they pertain to starter operation
III. Function and construction of starters and starter circuits
IV. Function and construction of switches
  A. Solenoid
  B. Magnetic
V. Function and construction of starter drives
  A. Bendix
  B. Overrunning
  C. Dyer
  D. Gear reduction-type drives
VI. Typical service problems
  A. Starter clicks but does not turn
  B. "Machine gunning"
  C. Starter disengages too soon
  D. Starters turns, but does not engage
  E. Locked starter drive
  F. Slow-turning starter
VII. Cranking motor bench tests
  A. Free load-running tests
    1. Low free speed—high current draw
    2. Failure to operate—high current draw
    3. Failure to operate—no current draw
    4. Low free speed—low current draw
  B. Armature testing
    1. Shorts
    2. Grounds
    3. Opens
  C. Field testing
    1. Shorts
    2. Grounds
    3. Opens
  D. Case inspection
    1. Inspect and test for grounded terminals
    2. Inspect and test brush-holder assemblies
VIII. Interpretation of cranking motor test results

LABORATORY ACTIVITY

I. Disassemble and reassemble a Bendix-drive-type cranking motor
II. Dissassemble and reassemble an overrunning clutch-type cranking motor
III. Disassemble and reassemble a gear-reduction type cranking motor
IV. Demonstrate cranking motor-bench tests
V. Disassemble and reassemble a magnetic switch
VI. Disassemble and reassemble a solenoid

SHOP ACTIVITY

I. Remove cranking motor from automobile
II. Bench-test cranking motor
III. Clean the cranking motor
IV. Service the cranking motor armature
  A. Use commutator paper
  B. Turn and undercut the commutator
  C. Replace worn bushings
V. Reassemble, test, and install cranking motor on automobile
VI. Lubricate cranking motor

TUNEUP PROCEDURE

Instructional Unit	Number of hours in—		
	Classroom	Laboratory	Shop
10. The Testing Procedure	0	70	0
11. Customer Relations	2	0	0
12. Engine Mechanical Indications and Conditions	3	0	4
13. Starter Circuit Testing	2	0	4
14. Distributor Testing	3	0	3
15. Primary Ignition Circuit Testing	1	0	1
16. Secondary Ignition Circuit Testing	3	2	35
17. Charging Circuit Testing	5	15	10
18. Fuel System Testing	3	1	15
19. Carburetion	15	35	70
Total	37	123	142

The diagnosis procedure used to analyze today's engines and electrical components is a systematic analysis of the engine's mechanical condition, the starter, ignition, fuel, and charging circuits. The objective of the diagnosis is threefold: first, to locate the malfunction; second, to determine the cause of the malfunction; and, third, to service both the malfunction and the cause. The overall tuneup procedure is as follows:

I. Determine the nature of the customer's complaint; i.e., poor mileage, hard starting, faulty electrical performance, or fuel problems.

II. Area test: Test the various circuits to determine whether the malfunction is in the fuel, starting, ignition, or charging circuits.

III. Isolate the malfunction within the area that was located in step II. This can be traced quickly with instruments or by visual inspection.

IV. Perform the necessary service in order to restore the malfunctioning unit or units to manufacturer's specifications.

This procedure is quick, accurate, and dependable. Emphasis should be placed on the fact that the analysis is fast and efficient only when it is made completely and involves no repair during the testing process.

This section will cover those tests necessary to make the overall engine diagnosis, and the tests necessary to pinpoint specific problems.

Unit 10. THE TESTING PROCEDURE

THE FOLLOWING TESTING PROCEDURE will serve as a guide for this procedure unit. The instrument test section is described by units. At the end of this section a demonstration of the entire procedure will be given. Trainees should practice these tests on a variety of engines. The entire procedure or analysis should be made within 30 minutes. Trainees should understand that they are: (1) Tuning an engine; (2) Using a system to determine where trouble exists; and (3) Looking for other items in need of attention so they can merchandise needed service to the customer.

Emphasis should be placed on making or selling a "complete" analysis so that maximum customer satisfaction will result. Stress the fact that "comebacks" are costly and do not build goodwill. A partial analysis, or a shortcutting of a procedure, does not promote business or provide salable service. When a customer is sold a tuneup, he should know what he is buying. Each and every customer should receive the same uniform and standardized analysis and service.

Trainees should practice this procedure for a minimum of 2 weeks. No repair service should be rendered during this preliminary training. At the end of this practice period, live work should be added to the testing procedure. This combination of testing and servicing the electrical and fuel systems is known as a "complete" engine tuneup.

TIME ALLOCATION

Laboratory, 70 hours

TEACHING GUIDE

By explaining the testing procedure as it is demonstrated, the trainees should be able to grasp the total concept of a tuneup. Trainees must understand that there is no short-cutting of this procedure. Short-cutting could well lead to incorrect diagnosis and service, and consequent customer dissatisfaction.

DISCUSSION TOPICS

I. Instrument tests
  A. Engine mechanical condition tests
    1. Compression test
    2. Cylinder leakage test
    3. Cranking vacuum test
  B. Battery testing
    1. Visual inspection
    2. Light-load test
    3. High-rate discharge test
    4. Hydrometer test
  C. Starter testing
    1. Visual inspection
    2. Starter amperage draw test
    3. Cable and switch tests
    4. Cranking voltage test
  D. Distributor testing
    1. Visual inspection
    2. Distributor resistance test
    3. Dwell test
    4. Dwell variation test
    5. Advance tests
    6. Timing
  E. Primary system testing
    1. Visual inspection
    2. Ballast resistor tests
    3. Primary circuit-resistance test
  F. Secondary system testing
    1. Visual inspection
    2. Polarity testing
    3. Required voltage test
    4. Available voltage test
    5. Secondary insulation test
    6. Secondary resistance test
    7. General overall engine analysis with the use of the scope
  G. Charging system testing
    1. Visual inspection
    2. Circuit-resistance test
    3. Voltage-limiter test
    4. Current-limiter test
  H. Fuel system tests and checks
    1. Visual inspection
    2. Fuel pump pressure test
    3. Fuel pump volume test
    4. Final hot idle adjustment
    5. Fast idle speed
    6. Throttle linkage—wide open position
    7. Accelerator pump action
    8. Choke unloader
    9. Choke operation and setting

II. Mechanical service
  A. Tighten nuts, bolts, and screws on:
    1. Intake manifold
    2. Exhaust manifold
    3. Carburetor base
    4. Carburetor cover
    5. Generator and bracket
    6. Starter housing
    7. Power assemblies and brackets
    8. Fuel pump mounting flange
  B. Inspect condition of:
    1. Commutator in generator and starter
    2. Brushes in generator and starter
    3. Cooling system and hoses
    4. Fuel system filters
    5. Fan belts
    6. Positive crankcase ventilation valve
  C. Free-up action on:
    1. Manifold heat-control valve
    2. Carburetor choke assembly
    3. Fuel system linkage

III. Safety service
  A. Check headlights
  B. Check tail lights
  C. Check brake lights
  D. Check turn signals
  E. Check horns
  F. Check parking lights
  G. Check seat belts
  H. Check general condition of tires
  I. Check general condition of exhaust system
  J. Check hand-brake operation
  K. Check brake-pedal height
  L. Check windshield wiper blades and arms
  M. Check rear-view mirror

Unit 11. CUSTOMER RELATIONS

THE PROMOTION OF CUSTOMER SATISFACTION is basic to general business operation. Proper attitude towards the customer and good service work together in promoting customer satisfaction, which, in turn, promotes better business.

TIME ALLOCATION

Classroom, 2 hours

TEACHING GUIDE

Use some typical customer problems as examples to illustrate the value of questioning the customer.

DISCUSSION TOPICS

I. Typical service questions to customers
  A. How long has this condition existed?
  B. When does it occur? (Under acceleration, cruising, going up hill, etc.)
  C. Have you had any work done recently?
  D. How about oil consupmtion?
  E. How long has it been since your (plugs, air cleaner, points, etc.) have been changed?
II. Related selling
III. The repair order
  A. Filling out the order
  B. Specific repair data (agreement)
  C. Work authorization by customer signature
IV. Road testing before repair
  A. To determine specific operational malfunction
  B. Selling related service
  C. Offering personal service to customer. EXAMPLE: Take him to his office or offer to deliver his automobile when completed
V. Road testing after repair

Unit 12. ENGINE MECHANICAL INDICATIONS AND CONDITIONS

ONE OF THE REQUIREMENTS for engine tune-up is a mechanically sound engine. Compression pressures have a direct relationship to power delivered to the crankshaft, fuel burning time, engine idle, oil consumption, carburetor performance, and acceleration. The following tests provide a means of getting the maximum information pertaining to the engine mechanical condition.

TIME ALLOCATION

Classroom, 3 hours; shop, 4 hours

TOOLS AND MATERIALS

I. Hand tools kit
II. Compression tester
III. Cylinder leakage tester
IV. Vacuum gauge

TEACHING GUIDE

Explain use of equipment and its role in making the test. Discuss the various testing methods that can be used and then have trainees make the tests on automobiles in the shop.

DISCUSSION TOPICS

I. The compression test
  A. Purpose of the test
  B. How to use test equipment
  C. How to make test
  D. Interpretation of test results
  E. Specifications
II. Cylinder leakage test
  A. Purpose of test
  B. How to use test equipment
  C. How to make test
  D. Interpretation of test results
  E. Specifications

III. Cranking vacuum test
  A. Purpose of the test
  B. How to use the gauge
  C. How to make the test
  D. How to interpret test results
IV. Spark plug servicing
  A. Type of plugs used
    1. Standard
    2. Cold plug
    3. Hot plug
  B. Analyze plug condition
    1. Oil-fouled
    2. Gas-fouled
    3. Normal
  C. Service the plugs
    1. Cleaning
    2. Filing
    3. Re-gapping
  D. Specifications
    1. Gap
    2. Type
    3. Conversion charts

SHOP ACTIVITY

I. Make a compression test
  A. Dry test
  B. Wet test
II. Make cylinder leakage test
III. Make a cranking vacuum test
IV. Collectively analyze all test results. This will provide a maximum number of experiences with test interpretations.
V. Remove spark plugs, analyze, clean and reinstall

Unit 13. STARTER CIRCUIT TESTING

STARTING PROBLEMS are a common complaint at most service centers. They are sometimes complex, involving the fuel system, electrical system, and even the engine mechanical condition. The tests necessary to diagnose starter problems are simple and require very little time. With proper interpretation of test results, malfunctions should be detected and corrected quickly.

TIME ALLOCATION

Classroom, 2 hours; shop, 4 hours

TOOLS AND EQUIPMENT

I. High-rate discharge tester
II. Voltmeter: 0—16-volt range
III. Ammeter: 0—600-amp range

TEACHING GUIDE

Review starter information given prior to this session. Discuss typical starter problems, tests, and typical repairs. Have trainees make tests in detail in the shop. They should study the use of the equipment as well as procedures.

DISCUSSION TOPICS

I. Types of starter complaints
  A. Hard starting when cold
  B. Hard starting when hot
  C. Starter will not engage
  D. Starter will not stay engaged
  E. Starter turns engine over too slowly
  F. Starter solenoid just clicks
II. Battery capacity test
  A. Value of this test to starter diagnosis
  B. Use of this test with relation to starter amperage draw test and hookup
III. Starter amperage draw test
  A. Purpose of the test
  B. Interpretation of test results
    1. High amperage readings
    2. Low amperage readings
IV. Cable and switch tests
  A. Purpose of the test
  B. Circuits to be tested
    1. Insulated circuit
    2. Ground circuit
  C. Component testing
    1. Testing of each starter cable
    2. Testing of each cable connection
    3. Testing of starter switch mechanism

SHOP ACTIVITY

I. Perform battery capacity test
II. Perform starter amperage draw test
III. Perform overall system test of cables and switches
IV. Perform tests of individual components to isolate trouble
V. Analyze test results collectively

NOTE: If possible, have trainees perform tests on different automobiles to become familiar with the solenoid circuit, the magnetic switch circuit, and the mechanical switch circuit.

Unit 14. DISTRIBUTOR TESTING

THE PURPOSE OF THIS UNIT is to introduce the testing procedure for distributors and their components. Emphasis should be placed on the interpretation of test specifications and results.

TIME ALLOCATION

Classroom, 3 hours; shop, 3 hours

TOOLS AND MATERIALS

I. Several distributors of various types
II. Several examples of ignition contact points
III. Condensers
IV. Dwell meter
V. Timing light
VI. Advance tester (on-the-car type)
VII. Hand tool kit

TEACHING GUIDE

Review distributor operation and function. Discuss testing procedures, explaining the need for testing and interpretation of test results. Demonstrate each test procedure and have the trainees perform each phase in the laboratory or shop.

DISCUSSION TOPICS

I. Review distributor function and operation

II. Distributor resistance test
  A. Purpose of the test
  B. Methods of testing
    1. Dwell meter
    2. Voltmeter
  C. Explanation of test results
  D. Correcting high-resistant problems

III. Dwell test
  A. Definition of dwell
  B. Relationship of dwell to ignition timing
  C. Relationship of dwell to point gap
  D. Methods of testing dwell
    1. Dwell meter
    2. Scope wave form
      a. Percent of dwell
      b. Measurement of wave form on scope
    3. Methods of adjusting dwell by type

VI. Dwell variation test
  A. Purpose of the test
  B. Method of making the test
  C. Interpretation of test results
    1. Breaker plate wear
    2. Bent shaft
    3. Worn bushings
    4. Point problems

V. Basic timing
  A. Review of test studied earlier
  B. Set timing after setting dwell
  C. Interpreting specifications
  D. Method of using timing light

VI. Timing advance test
  A. Purpose of mechanical advance
    1. Relation to engine performance
    2. Types of advance curves
  B. Purpose of vacuum advance
    1. Relation to engine economy
    2. Working relation with mechanical advance

C. Interpreting test specifications
D. Methods of testing
E. Interpreting test results

VII. Condensers
A. Purpose of the condenser
B. Methods of testing condenser
1. Series resistance
2. Capacity
3. Leakage

SHOP ACTIVITY

I. Test for distributor resistance
II. Test for dwell
III. Test for dwell variation
IV. Perform advance tests

NOTE: Isolate vacuum advance test results from mechanical advance results.

V. Change dwell on the car to a given specification, to familiarize trainee with adjustment procedure
VI. Use condenser tester
A. Test for capacity
B. Test for leakage
C. Test for series resistance

Unit 15. PRIMARY IGNITION CIRCUIT TESTING

THE FOLLOWING TESTS are important in determining whether or not the primary ignition circuit is correctly wired. The purpose of these tests is to determine if there are any grounds, high-resistant connections, or opens in the primary circuit.

TIME ALLOCATION

Classroom, 1 hour; shop, 1 hour

TOOLS AND MATERIALS

I. Voltmeter: 0—16-volt range

TEACHING GUIDE

Explain the purpose of the tests and the procedure for testing. The goal of this discussion is the interpretation of test results. Cite many examples of possible malfunctioning conditions that could occur and have the class discuss what the test results might be.

DISCUSSION TOPICS

I. Primary circuit voltage test (voltmeter connected between coil input terminal and ground)
A. Point open readings
1. Low battery
2. Ground circuit—coil to distributor
3. Ground in cranking circuit
B. Point closed readings
1. Resistor values
2. Ground circuit
3. High-resistance circuit
4. Open circuit

II. Cranking voltage test
A. Available voltage for ignition
B. Value as an overall general condition test
1. Battery
2. Cables and switches
3. Starting circuit

SHOP ACTIVITY

I. Primary circuit voltage test
II. Cranking voltage test
III. Identify and trace the starting circuit on various automobiles to include:
A. Resistor circuit
1. Ballast resistor
2. Wire resistor
B. Starting method
1. Wire from solenoid
2. Switch start
3. Type of by-pass circuit

Unit 16. SECONDARY IGNITION CIRCUIT TESTING

USING AN OSCILLOSCOPE is the modern method of analyzing the secondary ignition circuit. This instrument, referred to as the "scope," produces a wave form that illustrates the function of the ignition circuit under actual engine operating conditions. In order to interpret the scope or test patterns, it is important that the basic wave form be completely understood.

TIME ALLOCATION

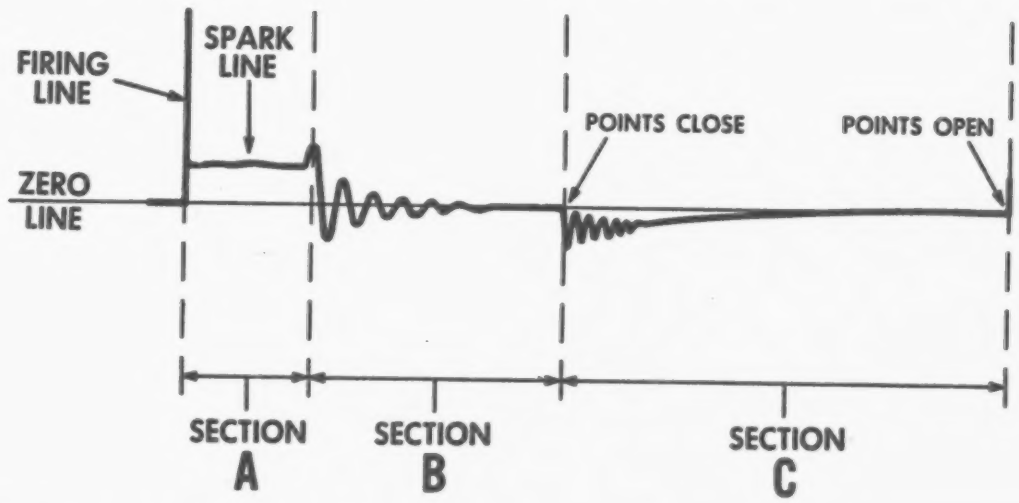
Classroom, 3 hours; laboratory, 2 hours; shop, 35 hours

TOOLS AND MATERIALS

I. Oscilloscope
II. Insulated pliers
III. Jumper wires (secondary)
IV. Spark plug adapters
V. Scope simulator (optional)

TEACHING GUIDE

Because various manufacturers of the scope use different terminology, the following illustration represents a basic and easy-to-understand approach for instructional purposes.



Section A could be referred to as the "secondary" area. Section B could be referred to as the "coil and condenser" area, and Section C as the "primary" area. A considerable amount of time is allocated to the shop session so that ample time can be given to the actual viewing of many different scope patterns.

DISCUSSION TOPICS

I. Basic scope pattern identification
  A. Parts of the pattern
    1. Secondary area (A section)
    2. Coil and condenser area (B section)
    3. Primary area (C section)
  B. Components being tested by area
    1. Secondary area
      a. Secondary wires
      b. Spark plugs
      c. Distributor cap
      d. Distributor rotor
      e. Fuel mixture
    2. Coil and condenser area
      a. Coil failure
      b. Condenser leakage
    3. Primary area
      a. Point closing action
      b. Point opening action
      c. Point problems
        (1) Point bounce
        (2) Arcing points
        (3) Dwell
II. How to operate the scope
  A. Scope connections to engine
  B. Scope controls for pattern observation
III. Pattern distortions vs. electrical problems
  A. Explain what happens to the pattern lines in section A when trouble occurs

B. Explain what happens to the pattern lines in section B when trouble occurs
C. Explain what happens to the pattern lines in section C when trouble occurs

IV. Methods of isolating specific trouble with scope
A. Use of jumper (secondary) wires
B. Removal of secondary wires individually
C. Exchanging spark plug in a faulty cylinder to determine specific fault
1. Internal problem
2. Plug problem
3. Wire problem

LABORATORY ACTIVITY

I. Show and explain what constitutes a good scope pattern on the scope simulator

II. Show and explain, one at a time, the various faults that can be simulated on the scope simulator

SHOP ACTIVITY

I. Select an automobile which produces an excellent pattern on the scope as the first demonstration for the class

NOTE: Trainees should get accustomed to seeing and understanding a good pattern before seeing the faulty patterns. If the trainees are exposed to faulty patterns to soon, they will not have the background for distinguishing a good pattern from a faulty one.

II. Have each trainee connect a scope to an automobile and analyze the pattern.

NOTE: The object is to have trainees see many different patterns and analyze them collectively.

III. Continue with shop session. Let trainees work in groups and continue to test engines with the scope. They should become familiar with scope operation and a variety of patterns.

NOTE: This unit will be most effective when a number of vehicles are used.

Unit 17. CHARGING CIRCUIT TESTING

THE PURPOSE OF THIS UNIT is to explain and demonstrate the charging circuit testing procedure. Service procedures for all components of the charging circuit, including the battery, generator, regulator, and wiring should be discussed, demonstrated, and practiced.

TIME ALLOCATION

Classroom, 5 hours; laboratory, 15 hours; shop, 10 hours

TOOLS AND MATERIALS

I. Battery post adapter
II. Voltmeter: 0—20-volt range
III. Ammeter: 0—60-amp range
IV. High-rate discharge tester
V. Light-load tester
VI. Variable field rheostat
VII. Hand tool kit
VIII. Hydrometer

TEACHING GUIDE

After discussing the classroom topics, demonstrate the test procedures on an automobile. Analyze the test results and discuss the service needs that might be required to correct the malfunctions. Trainees should repeat these demonstrations until they fully understand the testing procedures.

DISCUSSION TOPICS

I. Battery analysis
A. Hydrometer test
B. Light-load test
C. Interpretation of battery test results

II. Servicing the battery
  A. Slow charging
  B. Boost charging
III. Visual inspection of circuits
  A. Generator
  B. Brushes
  C. Fan belt
  D. Regulator contacts
  E. Wires and connections
IV. Generator—regulator testing
  A. Circuit resistance test
  B. Generator output test
  C. Voltage control test
  D. Cutout or load relay test
V. Removal and installation of components
  A. Battery
  B. Generator
  C. Regulator
VI. Quick tests for nonfunctioning circuits
  A. A-type D. C. generator
  B. B-type D. C. generator
  C. A. C. circuit

LABORATORY ACTIVITY

I. Demonstrate battery testing

II. Demonstrate charging circuit tests on A-type D. C. generator circuit

III. Demonstrate charging circuit tests on B-type D. C. generator circuit

IV. Demonstrate charging circuit tests on A. C. charging circuit

V. Analyze the results of above tests and explain the services needed in each case and why it is needed

VI. Demonstrate minor service adjustments on each type of charging circuit

SHOP ACTIVITY

I. Analyze a circuit A—D. C. charging circuit

II. Analyze a circuit B—D. C. charging circuit

III. Analyze an A. C. charging circuit

IV. Recommend service needs for each circuit tested

V. Make minor service adjustments necessary to correct any malfunctions discovered during the analysis

Unit 18. FUEL SYSTEM TESTING

. THE FUEL SYSTEM on automotive vehicles includes the tank, fuel lines, pump, filters, carburetor intake manifolds, and air cleaners. This unit is confined to these items with the exception of the carburetor and manifolds. Many fuel system problems are the result of inadequate service to the various components of this system. Proper testing and servicing techniques are presented in this unit.

TIME ALLOCATION

Classroom, 3 hours; laboratory, 1 hour; shop, 15 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Vacuum gauge and fittings
III. Fuel pump tester
IV. One-quart container
V. Flaring tool kit
VI. Manifold heat-control solvent

TEACHING GUIDE

Discuss the classroom topics, including the servicing and testing techniques as they apply. Demonstrate the fuel system tests in the laboratory and then have the trainees perform these tests on automobiles.

DISCUSSION TOPICS

I. Description of the system
  A. Fuel tank
    1. Construction
    2. Venting system
    3. Tank—gas-gauge unit

CAUTION: Do not service any portion of the tank in a training program. There must be NO tank cleaning, tank repair, or storage of gasoline in shop.

B. Fuel pump
   1. Types of pumps
      a. Single action
      b. Double action
      c. Electric
   2. Principles of pump operation
      a. Single action
      b. Double action
         (1) Oil-consumption problems
      c. Electric

C. Fuel lines
   1. Steel lines
   2. Flexible lines
      a. Visual inspection
      b. Procedure for removing and replacing
      c. Procedure for flaring a gas line
      d. Types of fittings and connections used

D. Manifold heat-control valve
   1. Purpose of the valve
   2. Checking and servicing the valve

II. Testing the fuel pump
   A. Pressure test
   B. Volume test
   C. Vacuum test
      1. At pump
      2. At end of flexible line
      3. At tank connections

III. Filters and filter service
   A. Types of filters
      1. Air cleaner
      2. In-line filters
      3. Carburetor filters
      4. Fuel-pump filter
   B. Methods of testing filters
      1. Combustion tests
      2. Air-cleaner light test
      3. In-line filter replacement
      4. Location and replacement procedure of carburetor filters
      5. Cleaning fuel pump filters

LABORATORY ACTIVITY

I. Demonstrate use of flaring tool

II. Demonstrate fuel pump tests
   A. Pressure test
   B. Volume test
   C. Vacuum tests

III. Demonstrate testing procedures used for the various filters

SHOP ACTIVITY

I. Locate and trace the entire fuel system from tank to carburetor

II. Check filters and manifold heat control on an automobile

III. Test fuel pumps on the automobile

Unit 19. CARBURETION

THE PURPOSE OF THIS UNIT is to provide the trainee with an understanding of carburetion. The unit will include a review of engine fundamentals as they apply to carburetion, the fundamentals of carburetion, carburetor systems and adjustments, and carburetor service procedures.

TIME ALLOCATION

Classroom, 15 hours; laboratory, 35 hours; shop, 70 hours

TOOLS AND MATERIALS

I. Carburetor specifications

II. Representative carburetors
   A. Single-barrel, double-barrel, four-barrel Rochester
   B. Single-barrel, double-barrel, four-barrel Carter
   C. Single-barrel, double-barrel, four-barrel Ford or Holly

III. Hand tool kit

IV. Carburetor service kit

TEACHING GUIDE

Because of the variety and complexity of modern carburetors, teaching the carburetor by circuits rather than by make is recommended. After discussing the suggested topics, have the trainees work in groups, disassembling the various carburetors one at a time and tracing all the circuits. When reassembling, trainees should perform all the adjustments which are necessary for each type of carburetor. After they have studied several types of carburetors, they should service problem carburetors from current model automobiles.

DISCUSSION TOPICS

I. Introduction to carburetion
  A. Review of internal combustion engine fundamentals
    1. Four-stroke cycle
    2. Compression ratio
    3. Compression pressures
    4. Valves and camshaft function
    5. Valve overlap
  B. Fuel system components
    1. Fuel tank
    2. Fuel lines
    3. Fuel pump
    4. Carburetor
    5. Air cleaners
    6. Fuel filters
  C. Other conditions affecting carburetion
    1. Engine mechanical condition
      a. Compression pressures
      b. Valve adjustments
      c. Intake manifold leaks
      d. Clogged air cleaner
      e. Burned out econol tube
    2. Electrical system condition
      a. Spark plugs
      b. Vacuum advance
      c. Centrifugal advance
      d. Timing
    3. Exhaust system

II. Carburetor fundamentals
  A. Air-fuel ratio definition
  B. Fluids and air flow—pressure vs. vacuum
  C. Pressure vs. air velocity
    1. Venturi action
    2. Types of venturi
  D. Carburetor venting
    1. External
    2. Internal

III. Carburetor circuits—functions and purposes
  A. Float
  B. Idle
  C. Off-idle
  D. High-speed
  E. Power
  F. Pump
  G. Choke

IV. Components of carburetors
  A. Float
    1. Needle and seat
    2. Float pontoon
  B. Idle
    1. Calibrated idle tubes
    2. Air bleeds
    3. Discharge holes
    4. Mixture screws
  C. Off-idle
    1. Discharge holes
    2. Main discharge nozzles
  D. High-speed circuit
    1. Main metering jets
    2. Main discharge nozzles
  E. Power circuit
    1. Power valve
    2. Power piston or diaphragm
    3. Vacuum passages
    4. Check balls
  F. Pump circuit
    1. Pump plunger or diaphragm
    2. Discharge check ball or needle
    3. Intake check ball
    4. Discharge passage
    5. Pump linkage
  G. Choke circuit
    1. Choke valve
    2. Choke piston
    3. Thermostatic coil spring
    4. Fast idle cam
    5. Related linkage
    6. Vacuum passages
    7. Heat passages

V. Carburetor service needs
  A. Specifications
  B. Special tools and gauges
  C. Trouble-shooting charts
  D. Cleaning chemicals
  E. Carburetor kits
    1. Gasket kit
    2. Service kit
    3. Complete overhaul kit

LABORATORY ACTIVITY

Trainees should follow this procedure as it applies on Carter, Rochester, and Ford or Holly carburetors. Both two- and four-barrel carburetors should be studied.

I. Identify various makes of carburetors
II. Determine car applications
III. Disassemble carburetor
IV. Identify all circuits within the carburetor
V. Assemble carburetor
VI. Adjust carburetor
  A. Float adjustments
    1. Height—toe and heel
    2. Drop
    3. Alignment
  B. Pump rod adjustments
  C. Choke adjustments
  D. Idle vent adjustments
  E. Unloader adjustments
  F. Secondary throttle lockout adjustments
  G. Secondary contour adjustments
  H. Throttle stop and mixture screw adjustments

SHOP ACTIVITY

I. Remove, clean, adjust, and replace a Carter carburetor
II. Remove, clean, adjust, and replace a Rochester carburetor
III. Remove, clean, adjust, and replace a Ford or Holly carburetor
IV. Check all carburetor adjustments on the car and make final idle adjustment

Section III.
SUSPENSION AND BRAKE SERVICE

INTRODUCTION TO WHEEL ALIGNMENT

Instructional Unit	Number of hours in—		
	Classroom	Laboratory	Shop
1. Suspension System	4	0	10
2. Alignment Factors	3	0	14
3. Alignment Specifications and Adjustments	2	10	0
4. Standard Steering Gears	4	14	0
5. Wheel Balancing	1	1	4
Total	14	25	28

The suspension systems used on modern automobiles are much more sophisticated in design than they were only a few years ago. The service requirements of these refined systems have also changed and have become more exacting. These changes have forced the alignment serviceman to become much more specialized.

The technical improvements in suspension systems have reduced but have not eliminated servicing. There is a much higher frequency of service requests today that are not adequately handled because the serviceman fails to properly diagnose the malfunction.

A good alignment serviceman must be a good diagnostician. A thorough inspection and analysis of an alignment problem will lead to an intelligent decision as to what repairs or adjustments are necessary. If a quality repair job is performed, the customer is certain to be pleased with the results. This leads to excellent customer relations and customer satisfaction, which in turn leads to a more profitable business. This unit is designed to offer to the trainee an opportunity to prepare himself for employment in this phase of automotive service. By mastering each of the following introductory units on wheel alignment, the trainee will be well prepared for the alignment procedure units which follow in this section.

Unit 1. SUSPENSION SYSTEMS

THE PURPOSE OF THIS UNIT is to acquaint the trainee with the various automotive suspension systems. A thorough understanding of these systems is imperative before the trainee can be expected to diagnose suspension system malfunctions and/or perform the necessary service work to correct these malfunctions. Emphasis should be placed on the types of systems the trainee will encounter most frequently and the names and functions of the components of each system.

TIME ALLOCATION

Classroom, 4 hours; shop, 10 hours

TOOLS AND MATERIALS

I. Alignment hand tool kit

II. Hand tool kit

TEACHING GUIDE

Several automobiles should be available, each with a different type of suspension system. Direct application of the discussion topics to the automobile can then be easily effected. A short period of time should be spent on the history and development of the systems.

Shop time should be used to study suspension systems on a representative group of automobiles. Emphasis, during this session, should be on parts identification, operating characteristics of each system, and minor service procedures for each system.

DISCUSSION TOPICS

I. Purpose of wheel alignment
   A. Prevention of tire wear
   B. Vehicle driving ease
   C. Safety

II. History and evolution of the suspension system
   A. Invention of the wheel
   B. Wagon or buggy system
   C. "I" beam or solid axle
   D. Independent suspension
      1. Knee action
      2. Parallel arm suspension
   E. Spring design and application
      1. Leaf springs
      2. Coil springs
   F. Torsion bar suspension
   G. Air suspension
   H. Shock absorbers
   I. Wheels and tires

III. Suspension system types
   A. Front suspension systems
      1. "I" beam or solid axle
         a. Types of pivots
         b. Types of springs and shackles
      2. Independent suspension systems
         a. King-pin type
         b. Ball-joint type
         c. Coil-spring supported
         d. Torsion-bar supported
         e. Anti-dive designs
         f. Anti-roll designs
   B. Rear suspension systems
      1. Standard rear axle assembly
         a. Leaf-spring supported
         b. Coil-spring supported
      2. Independent rear suspension

IV. Typical suspension damage
   A. Normal wear conditions
      1. Pivots and king pins
      2. Ball joints
      3. Rubber bushings
      4. Linkage
      5. Shock absorbers
      6. Springs
   B. Abnormal wear conditions
      1. Faulty lubrication
      2. Misaligned parts
      3. Severe service
   C. Collision damage
      1. Frame members
         a. Cross members
         b. Spring pocket
         c. Frame horn
      2. Suspension linkage
         a. Upper control arm
         b. Lower control arm
         c. Steering knuckle
         d. Springs
      3. Steering linkage
         a. Tie rods
         b. Steering arms
         c. Idler arm
         d. Steering gear

V. Suspension system service
   A. Suspension linkage repair
      1. Parts replacement
      2. Adjustments
   B. Steering linkage repair
      1. Parts replacement
      2. Adjustments
   C. Spring service
      1. Leaf spring
      2. Coil spring
   D. Torsion bar service
      1. Parts replacement
      2. Adjustment
   E. Shock absorber service
      1. Filling older model shock absorbers
      2. Replacement techniques of modern shock absorbers
   F. Lubricating the suspension system

SHOP ACTIVITY

I. Using proper terminology, list the parts that are in need of adjustment or replacement on each suspension system available in the shop.

II. Inspect suspension system components to determine whether they need adjustment or replacement.

III. Service those items found to be unsatisfactory, such as ball joints, idler arms, tie rod ends, upper and lower pivots, and wheel bearings.

Unit 2. ALIGNMENT FACTORS

QUALITY ALIGNMENT WORK is possible only when the serviceman understands the factors that make up the complete alignment procedure. He must understand the angular relationship of the various units used in steering, its effect on the steering and handling characteristics of the automobile, and its effect on tire wear. He must know how to interpret specifications and to make the necessary repairs or adjustments which will result in a satisfactory alignment job.

TIME ALLOCATION

Classroom, 3 hours; shop, 14 hours

TOOLS AND MATERIALS

I. Specification charts
II. Caster—camber gauge
III. Toe gauge
IV. Tire scribe
V. Two-alignment turn tables
VI. Alignment hand tool kit
VII. Hand tool kit

TEACHING GUIDE

Discuss the alignment factors in detail with special emphasis on definition and application. Illustrate on the chalk board, or by some other visual means, the angles and dimensions encountered in the alignment process. Discuss and demonstrate the measuring devices and adjustment procedures involved in the alignment job. Use frequent practice sessions demonstrating measuring devices and procedures.

Discussion topics involving rear wheel tracking and wheel base dimensions are included as general information topics. Alignment corrections should not exceed minor part replacement and/or normal adjustment procedures.

DISCUSSION TOPICS

I. Front wheel alignment factors
  A. Camber
    1. Definition
    2. Effect of camber on tire wear
    3. Application to the automobile
    4. Methods of adjustment
    5. Definition of a degree as a unit of measurement
    6. Practical limits for specifications
    7. Measuring devices and procedures
    8. Effect of camber on vehicle driving characteristics
  B. Caster
    1. Definition
    2. Application to the automobile
    3. Effect of caster on vehicle driving characteristics
    4. Effect of caster on tire wear
    5. Methods of adjustment
    6. Practical limits for specifications
    7. Measuring devices and procedures
  C. Toe
    1. Definition
    2. Application to the automobile
    3. Effect of toe on vehicle driving characteristics
    4. Effect of toe on tire wear
    5. Methods of adjustment
    6. Specifications
    7. Measuring devices and procedures

D. Toe-out on turns (steering geometry)
   1. Definition
   2. Application to the automobile
   3. Effect of toe-out on turns on vehicle driving characteristics
   4. Effect of toe-out on turns on tire wear
   5. Correction procedures
   6. Practical limits for specifications
   7. Measuring devices and procedures

II. Rear wheel alignment factors
   A. Rear wheel camber
      1. Definition
      2. Application to the automobile
      3. Effect of camber on vehicle driving characteristics
      4. Effect of camber on tire wear
      5. Methods of adjustment or correction
         a. Standard rear axle
         b. Independent suspension
      6. Specifications and practical limits
      7. Measuring devices and procedures
   B. Rear wheel toe
      1. Definition
      2. Application to the automobile
      3. Effect of rear wheel toe on vehicle driving characteristics
      4. Effect of rear wheel toe on tire wear
      5. Methods of adjustment or correction
         a. Tube axle
         b. Independent suspension
      6. Specifications and practical limits
      7. Measuring devices and procedures
   C. Rear wheel track
      1. Definition
      2. Application to the automobile
      3. Effect of rear wheel tracking on vehicle driving characteristics
      4. Effect of rear wheel tracking on tire wear
      5. Methods of correction
         a. Tube axle—leaf spring
         b. Tube axle—coil spring
         c. Independent suspension
      6. Specifications and practical limits
      7. Measuring devices and procedures
   D. Wheel base dimensions
      1. Front suspension members
      2. Rear suspension
         a. Standard rear axle
         b. Independent suspension
      3. Specifications
         a. Information sources
         b. Practical limits
      4. Measuring procedures
      5. Correction procedures

SHOP ACTIVITY

I. Measure alignment factors on automobiles incorporating as many suspension types as possible
II. Record results and compare them to vehicle specifications
III. Study the various automobiles for the proper method of adjusting, and types of adjusting devices used for the correction of alignment factors

Unit 3. ALIGNMENT SPECIFICATIONS AND ADJUSTMENTS

BEFORE A FAULTY SUSPENSION CONDITION can be corrected, a systematic analysis must be performed. When this is accomplished, and method of repair determined, the actual service work may be performed. The process of interpreting specifications and understanding where and how to make basic suspension system adjustments is the purpose of this unit.

TIME ALLOCATION

Classroom, 2 hours; laboratory, 10 hours

TOOLS AND MATERIALS

I. Specification charts
II. Caster—camber gauge
III. Toe gauge
IV. Tire scribe
V. Two-alignment turn tables
VI. Hand tool kit
VII. Alignment tool kit

TEACHING GUIDE

Discuss the topics in detail using as many practical examples as possible. Use some specifications exemplifying poor vehicle handling characteristics and have the trainees analyze them. These examples should illustrate pulling or lead conditions, bad tire wear conditions, and road wander conditions. The trainees should choose the specifications, and decide how to make the adjustments necessary to correct the malfunction. Effective examples will include specific car model and suspension type.

DISCUSSION TOPICS

I. Sources of alignment specifications
   A. Equipment manufacturers' specifications
   B. Service manual specifications
   C. Automobile manufacturers' specifications
II. Factors to be considered in the selection of alignment specifications
   A. Manufacturers' recommended specifications
   B. Practical specification limits
   C. Allowable tolerance
   D. Visible tire-wear indications
   E. Customer-driving habits
   F. Vehicle-loading situation
   G. Road crown correction
III. Methods of adjustment for caster and camber
   A. For kingpin front end
      1. Eccentric pin
      2. Eccentric bushing
      3. Threaded sleeve
   B. For ball-joint front end
      1. Shims
      2. Eccentric cam
      3. Strut rod
      4. Eccentric washer
      5. Camber eccentric
   C. For rear suspension (camber only)
IV. Methods of adjusting toe
   A. On front suspension
   B. On rear suspension

LABORATORY ACTIVITY

I. Demonstrate the following
   A. Check and record existing vehicle alignment specifications
   B. Analyze these readings with relationship to the handling characteristics of the vehicle
   C. Determine service needed to correct vehicle alignment problems
   D. Make necessary adjustments to correct vehicle alignment problems

Unit 4. STANDARD STEERING GEARS

STEERING GEAR ADJUSTMENT, though often overlooked, is an important part of the complete alignment procedure. Since the steering gear is in constant use when driving, it becomes imperative that it be properly serviced, both for safety and for customer satisfaction. The purpose of this unit is to present general information and service information about standard steering gears.

TIME ALLOCATION

Classroom, 4 hours; laboratory, 14 hours

TOOLS AND MATERIALS

I. Specifications
II. Hand tool kit
III. Alignment hand tool kit

TEACHING GUIDE

The introductory information about steering gears should be covered in the classroom. Steering gear units, special tools, and specifications should be used in the classroom to assist in the practical application of of this unit.

General service procedures for the various types of steering gears should be taught in the classroom followed by demonstrations in the laboratory. Trainees should then disassemble and assemble a representative group of standard steering gears. During this process they should study nomenclature, operating characteristics, and recommended service procedures for each of the steering gears.

Practical application should be made through the use of a representative group of automobiles. Service procedures on these automobiles should follow the particular manufacturer's recommendations.

DISCUSSION TOPICS

I. Introduction to manual steering gears
  A. Purpose of the steering gear
    1. As a link between the driver and the wheels
    2. As a device to produce mechanical advantage for steering effort
  B. Identification of steering gears
    1. By manufacturer's trade name or symbol
    2. By physical construction
    3. By automobile application
  C. The importance of steering gear adjustment to the alignment job
    1. Automobile safety
    2. As a means of extending the service life of the steering gear
  D. Mechanical service procedure
    1. Preliminary inspection of steering gear and linkage
    2. Interpreting specifications
    3. Proper methods of disconnecting steering gear from steering linkage
    4. Locating register marks for steering wheel and pitman arm
    5. Measuring steering gear preload
    6. Using manufacturer's special service tools
    7. Lubricating the steering gear

II. The Saginaw-type steering gears
  A. The series 500 steering gear
    1. General classification
      a. By design
      b. By automobile application
    2. Operating characteristics
    3. Adjustment procedures
      a. Sequence
      b. Specifications
    4. Steering gear lubrication
  B. The model 420 and 450 steering gears
    1. General classification
      a. By design
      b. By automobile application
    2. Operating characteristics
    3. Adjustment procedures
      a. Sequence
      b. Specifications
    4. Steering gear lubrication
  C. The model 320 steering gear
    1. General classification
      a. By design
      b. By automobile application
    2. Operating characteristics
    3. Adjustment procedures
      a. Sequence
      b. Specifications
    4. Steering gear lubrication

III. The Gemmer steering gear
  A. The model 305, 335, and 375 steering gears
    1. General classification
      a. By design
      b. By automobile application
    2. Operating characteristics
    3. Adjustment procedures
      a. Sequence of adjustment
      b. Specifications
    4. Steering gear lubrication
  B. The model 250, 300, and 330 steering gears
    1. General classification
      a. By design
      b. By automobile application
    2. Operating characteristics
    3. Adjustment procedures
      a. Sequence
      b. Specifications
    4. Steering gear lubrication

IV. The Ross cam and lever steering gears
  A. General classification
    1. By design
    2. By automobile application
  B. Operating characteristics
  C. Adjustment procedures
    1. Type I
      a. Sequence
      b. Specifications

2. Type II
   a. Sequence
   b. Specifications
3. Type III
   a. Sequence
   b. Specifications

D. Steering gear lubrication

LABORATORY ACTIVITY

I. Disassemble a representative group of steering gears following manufacturers' instructions
II. Identify ali parts of each of the steering gears
III. Study operating characteristics of each steering gear while it is disassembled
IV. Reassemble steering gears following the particular manufacturer's recommendations
V. Adjust each steering gear worked on

Unit 5. WHEEL BALANCING

WHEEL BALANCING is one of the simplest service operations that can be performed on the automobile. It is known that as high as four out of five cars driven down the highway are in need of wheel-balancing service. An out-of-balance condition is not only a safety hazard, but it is also destructive to other vehicle components. The purpose of this unit is to introduce the trainee to wheel-balancing service so he can in turn render this service to the motoring public.

TIME ALLOCATION

Classroom, 1 hour; laboratory, 1 hour; shop, 4 hours

TOOLS AND MATERIALS

I. Wheel weight assortment
II. Weight removing and installing tool
III. Hub cap mallet
IV. Lug wrench
V. Dust cap removing tool
VI. Torque wrench
VII. Tire run-out gauge
VIII. Cotter keys
IX. Hand tool kit

TEACHING GUIDE

Discuss the following topics so the trainee has a basic understanding of wheel balancing. Demonstrate the use of the on-the-car balancer and the off-the-car balancer.

DISCUSSION TOPICS

I. Wheel balancing service
   A. Wheel balance for safety
   B. Wheel balance for extended tire life
   C. Wheel balance for extending the life of the parts used in the suspension system
   D. Wheel balance for riding comfort
II. Tire conditions and their effect on wheel balance
   A. Tire wear conditions
   B. Tread run-out
III. Wheel and rim problems
   A. Eccentricity
   B. Side run-out
IV. Wheel balancing processes
   A. Static balance
      1. On the car
      2. Off the car
   B. Dynamic balance
      1. On the car
      2. Off the car
   C. Kinetic balance

LABORATORY ACTIVITY

I. Demonstrate wheel balancing using the on-the-car balancer
II. Demonstrate wheel balancing using the off-the-car balancer

SHOP ACTIVITY

I. Balance wheels using the on-the-car balancer
II. Balance wheels using the off-the-car balancer

ALIGNMENT PROCEDURE

Instructional Unit	Number of hours in—		
	Classroom	Laboratory	Shop
6. Diagnose Suspension System Problems	2	2	7
7. Service Suspension System	2	5	35
8. Measure Alignment Factors	4	2	35
9. Adjust Suspension System	4	6	70
Total	12	15	147

The suggested alignment procedure is divided into four separate units as follows:

I. Diagnose suspension system problems
II. Service suspension systems
III. Measure alignment factors
IV. Adjust suspension system

Trainees should practice on a variety of automobiles and the entire procedure should take no longer than one hour to complete. Trainees should realize that employers normally expect five to seven alignment jobs per day.

If damage resulted from a misaligned system, a diagnosis is made to determine the type of damage. Servicing the system may be required before the alignment is made if any components are badly worn or damaged. After all necessary services have been performed, the alignment factors can be measured. These measurements are then analyzed and compared to the manufacturer's specifications. Adjustments are then made in order to comply with these specifications.

Emphasis should be placed on using the proper procedure on each vehicle in need of alignment service, regardless of age or condition. Each and every customer will then receive the same standardized and uniform service.

Repairs or adjustments should be limited to those that must be made before the vehicle can be checked for alignment condition. Trainees should practice this procedure for at least 2 weeks in order to gain proficiency.

By demonstrating the alignment procedure and explaining what is being done at the same time, the trainees should be able to grasp the concept of wheel alignment. Trainees should understand that this procedure is designed to help them locate hidden damage that would hinder proper handling of a vehicle even after adjustments have been made. It will also help them develop the necessary speed which is essential for employment.

Unit 6. DIAGNOSE SUSPENSION SYSTEM PROBLEMS

A DIAGNOSIS of a suspension system problem should be made before any commitment is given the customer regarding costs and job completion time. It is possible that a vehicle may have been in a collision or has worn out suspension parts that would make a satisfactory alignment job impossible without extensive repair work. The purpose of this unit is to have the trainee understand why and how to make a fast diagnosis of suspension system problems.

TIME ALLOCATION

Classroom, 2 hours; laboratory, 2 hours; shop 7 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Alignment tool kit
III. Ball joint checking gauge
IV. Vehicle inspection check sheet
V. Assorted cotter keys

TEACHING GUIDE

After discussing the following topics in detail, the trainees should observe a demonstration on the method of diagnosing suspension system problems. Each phase of a diagnosis discussed in the classroom should be correlated to the demonstration. Trainees should then diagnose suspension malfunctions on several vehicles, fill out repair order forms describing the work to be completed, and then proceed to complete the alignment jobs.

DISCUSSION TOPICS

I. Classify vehicle alignment problems
  A. Customer interview
    1. Period of time or mileage between alignment jobs
    2. Previous work done on system
    3. Nature of the existing problem
  B. Road test vehicle
    1. Determine operating malfunction
    2. Determine needed auxiliary services and possible sales
      a. Tires
      b. Shock absorbers
      c. Brake service
      d. Electrical and fuel service
II. Visual inspection of the vehicle
  A. Analyzing tire wear conditions
    1. Worn suspension parts
    2. Abnormal driving or loading conditions
    3. Tracking problems
    4. Alignment adjustment problems
  B. Inspection for collision damage
    1. Misaligned sheet metal components
    2. Mismatched paint
    3. Uneven trim height
    4. Evidence of frame damage repair
    5. Misalignment of bumpers and body panels
  C. Inspect suspension system for loose parts and wear
    1. Lift and support vehicle
    2. Locate worn suspension parts
    3. Check ball joints
    4. Check steering linkage

LABORATORY ACTIVITY

I. Demonstrate the diagnosis of suspension system problems that should precede alignment job
II. Show trainees how to write out the repair order properly for authorization of this repair
III. Trainees should practice diagnosing suspension system problems and filling out the repair order on each unit diagnosed

Unit 7. SERVICE SUSPENSION SYSTEM

SERVICING THE SUSPENSION SYSTEM COMPONENTS may be a necessity before the alignment job can be properly completed. Some of the faulty components can be repaired rather quickly and easily while others may require considerable time and special equipment. This unit is designed to introduce the more frequent types of suspension system malfunctions and their corrective service procedures.

TIME ALLOCATION

Classroom, 2 hours; laboratory, 5 hours; shop, 35 hours

TOOLS AND EQUIPMENT

I. Hand tool kit
II. Alignment tool kit
III. Ball joint checking gauge
IV. Vehicle inspection check sheet
V. Acetylene welding unit
VI. Wheel bearing packer
VII. Wheel bearing grease
VIII. Grease gun (hand)
IX. Chassis grease
X. Cotter key assortment
XI. Steering gear lube
XII. Tension gauge (ounce)
XIII. Torque wrench (inch pound)

TEACHING GUIDE

Discuss the following topics with the trainees. Demonstrate the recommended service, checking procedures on only one side of the automobile. Ask a trainee to check the opposite side of the same automobile while observing him closely, and ask other trainees to tell him what to do. This will encourage class participation in the demonstrations. After the demonstrations, require the trainees to perform the necessary service checks and repairs on various automobiles.

DISCUSSION TOPICS

I. Suspension system component service
  A. King-pin and bushings
    1. Checking procedure
    2. Allowable limits for looseness
    3. Lubrication requirements
    4. Replacement procedure
  B. Ball joints
    1. Checking procedure
    2. Allowable limits for looseness
    3. Lubrication requirements
    4. Replacement procedure
  C. Pivot pin and bushings
    1. Checking procedure
    2. Allowable limits for looseness
    3. Lubrication requirements
    4. Replacement procedure
  D. Rubber bushing
    1. Checking procedure
    2. Replacement procedure
  E. Springs—leaf and coil
    1. Checking height and condition
    2. Replacement procedure
  F. Shock absorbers
    1. Checking procedure
    2. Replacement procedure
II. Steering gear service
  A. Adjust steering gear
    1. Determine need for adjustment
    2. Internal gear adjustments
    3. Gear to frame alignment
  B. Lubricate steering gear
III. Steering linkage service
  A. Tie rod ends
    1. Checking procedures
      a. Looseness
      b. Condition of threaded sleeve
    2. Lubrication requirements
    3. Replacement procedures
  B. Idler arm
    1. Checking procedure
    2. Lubrication procedure
    3. Replacement procedures
  C. Relay rod or connecting link
    1. Checking procedure
    2. Relay rod adjusting procedure
    3. Lubrication requirements
    4. Replacement procedures
IV. Front wheel bearing service*
  A. Lubrication requirements
  B. Replacement procedures
  C. Adjustment procedures

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*Refer to: Wheel bearing and seal service in the Service Orientation and Maintenance Operations section

LABORATORY ACTIVITY

I. Demonstrate the method of checking king-pins and bushing for excessive looseness
II. Demonstrate the method of checking ball joints for excessive looseness
III. Demonstrate the procedure used to locate a defective shock absorber
IV. Demonstrate how to free-up tie rod sleeves
V. Demonstrate how to adjust a relay rod

SHOP ACTIVITY

I. Service a set of front wheel bearings and seals
II. Remove and replace a defective set of ball joints
III. Remove and replace defective tie rod ends
IV. Remove and replace defective idler arm
V. Adjust a relay rod
VI. Install a set of shock absorbers

Unit 8. MEASURE ALIGNMENT FACTORS

WHILE SOME FACTORS of wheel alignment influence stability more than others, no one element alone imparts stability to the vehicle. One misaligned unit may destroy stability, cause rapid tire wear, or be the cause of a vehicle leading left or right or wandering. The purpose of this unit is to introduce the trainees to the proper methods of measuring the alignment factors.

TIME ALLOCATION

Classroom, 4 hours; laboratory, 2 hours; shop, 35 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Alignment tool kit
III. Caster–camber gauge
IV. One set graduated turntables
V. Leveling shims for rear wheels
VI. Turntable level checking fixture
VII. 12″ level
VIII. Tire scribe
IX. Toe-in gauge
X. Hydraulic jack
XI. Vehicle inspection check sheet

TEACHING GUIDE

Discuss the following topics in detail and then demonstrate the use of the various pieces of test equipment and the measurement process. After the demonstration ask the trainees to check and record the alignment factors of various automobiles.

DISCUSSION TOPICS

I. Preparation for measuring alignment factors
  A. Prepare stall area
    1. How to check for level condition
    2. How to compensate for uneven floor condition
  B. Prepare equipment
    1. How to check accuracy of equipment
    2. Check equipment for operating condition
  C. Position automobile for alignment check
    1. Pull vehicle on turntable by hand
    2. Shim rear wheels to level vehicle

Caution:

1. Never drive vehicle onto turntable
2. If raised portable stands are used, position rear wheels first, set hand brake and then position front wheels

II. Check vehicle alignment factors
  A. Camber
    1. Wheel position
    2. Gauge setting
    3. Interpreting gauge readings

B. Caster
   1. Wheel position
   2. Gauge setting
   3. Interpreting gauge readings
C. Toe-out on turns
   1. Wheel position
   2. Interpreting gauge readings
D. Toe
   1. Wheel position
   2. Gauge settings
   3. Interpreting gauge readings

NOTE: When using gauges that contact rim or tire, wheel run-out must be checked and compensated for

NOTE: Steering axis inclination should be checked whenever steering knuckle damage is suspected

E. Rear wheel alignment check
   1. Camber
   2. Toe
   3. Rear wheel track

LABORATORY ACTIVITY

I. Demonstrate the entire alignment checking process

II. Demonstrate the use of the equipment

SHOP ACTIVITY

I. Check alignment factors on various automobiles

II. Record test specifications and recommend ideal specifications to improve handling characteristics

Unit 9. ADJUST SUSPENSION SYSTEM

THE FINAL STEP in the alignment job is the adjustment of the suspension structural parts to obtain the maximum vehicle stability for handling ease. Trainees must be made to realize that no two makes or models of automobiles carry the same alignment specifications; therefore, they must always use and abide by the manufacturers' recommendations. The main purpose of this unit is to expose the trainee to as many adjusting techniques and problems as time will permit.

TIME ALLOCATION

Classroom, 4 hours; laboratory, 6 hours; shop, 70 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Alignment tool kit
III. Hydraulic jack
IV. Caster–camber wrench set
V. Alignment shim assortment
VI. Assorted cotter keys

TEACHING GUIDE

Discuss the selection of alignment specifications using direct application to typical problems. A number of sample problems should be presented to the trainees for practice. These problems should be analyzed in terms of tire wear characteristics, vehicle lead characteristics, vehicle handling characteristics, manufacturers' recommended specifications, and recommended operating specifications.

Adjustment procedures for the various suspension systems should be discussed followed by demonstrations on a variety of automobiles. Practical problems in shim placement for caster and camber adjustments should be presented. These problems should be analyzed in terms of the desired movement of either the upper or lower ball joint to achieve proper alignment.

The procedure for a complete alignment job should be presented to the trainees followed by a demonstration. The trainees should be encouraged to develop a technique for doing the complete alignment job quickly and efficiently.

DISCUSSION TOPICS

I. Selecting alignment specifications
   A. Interpreting specification charts
      1. Operating tolerance range
      2. Practical operating limits
   B. Considerations for operating conditions
      1. Alignment for the average driver
      2. Special loading conditions
      3. Special handling characteristics
      4. Tire wear problems
      5. Road crown pull

II. Suspension system adjusting procedure
   A. King-pin type
      1. Caster
      2. Camber
      3. Toe
   B. Ball joint type
      1. Caster and camber
      2. Toe

   NOTE: Adjust that side having limited movement first

   NOTE: Center steering wheel when toe adjustment is made

III. Rechecking the alignment job
   A. Checkpoints for suspension linkage
      1. Adjustments
      2. Mounting bolts
      3. Adjusting devices
      4. Locking devices
   B. Checkpoints for steering linkage
      1. Interference or binding
      2. Adjustments
      3. Locking devices
      4. Mounting bolts
   C. Final road test procedure
      1. Check spoke of steering wheel for center position
      2. Check for lead or wander conditions
      3. Check for vibration or shimmy

IV. Prepare automobile for delivery to customer
   A. Interior preparation
      1. Vacuum interior
      2. Clean steering wheel
      3. Clean glass
   B. Exterior preparation
      1. Remove hand prints from tires and exterior finish
      2. Clean glass

LABORATORY ACTIVITY

I. Demonstrate the adjustment procedure for automobiles having king-pin front ends

II. Demonstrate the adjustment procedure for automobiles having ball joint front ends with shim adjustments

III. Demonstrate the adjustment procedure for automobiles having ball joint front ends with shim and strut rod adjustments

IV. Demonstrate the adjustment procedure for automobiles having ball joint front ends with eccentric adjustments

V. Demonstrate the adjustment procedure for automobiles having ball joint front ends with eccentric and strut rod adjustments

VI. Demonstrate the procedure for a complete alignment job

SHOP ACTIVITY

I. Practice making adjustments on a selected group of automobiles

II. Practice the complete alignment procedure with a selected group of automobiles having a variety of suspension system types

AUTOMOTIVE BRAKES

Instructional Unit	Number of hours in—		
	Classroom	Laboratory	Shop
10. Brake Systems	4	3	0
11. The Hydraulic Brake	8	4	35
Total	12	7	35

"Drive carefully! The life you save may be your own"—is a well-known slogan designed to promote driving safety on the part of the motoring public. Newly licensed drivers are more aware of terms, such as stopping distance and reaction time, than many drivers who have been licensed for a number of years. Many of the written tests used in the process of acquiring a driver's license include questions pertaining to required stopping distance at a given speed. However, many drivers, whether or not they know these braking requirements, do not know the condition of the brakes on the cars they drive.

Currently, there are no laws governing the type of brake lining that can be sold on a brake service job. The automobile owner does not know whether he is purchasing a quality or an inferior lining. The difference in lining may mean the difference between life and death on the highway. The automotive serviceman can play a vital role in the national effort to reduce highway tragedies by learning proper and modern methods of servicing brake systems.

The objectives of this section are to provide the trainee with a practical understanding of the principles and operation of the brake system, the proper diagnosis and servicing of brake systems, and the knowledge of how to merchandise brake service.

Unit 10. BRAKE SYSTEMS

THE PURPOSE OF THIS UNIT is to introduce the trainee to the evolution of brake systems, the fundamental principles of braking, and a general classification of brake types. This information will serve as the foundation of this automotive brake service section.

TIME ALLOCATION

Classroom, 4 hours; laboratory, 3 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Brake service tool kit
III. Brake shoe centering gauge
IV. Brake mock-up assemblies
V. Reference manuals

TEACHING GUIDE

Discuss the classroom topics in detail. Use available brake training aids, such as mock-up units, charts, or reference manuals. If mock-up units are not available, representative automobiles may be used to great advantage, especially when discussing the classification section.

DISCUSSION TOPICS

I. The evolution of brake operating systems
  A. Early types
    1. Locked wheel
    2. Drag
    3. Snubber
  B. External contracting mechanical types
    1. Wheel tire brake
    2. Transmission brakes
    3. Two wheel—wheel—mounted drum
    4. Four wheel—wheel—mounted drum
  C. Internal expanding types
    1. Mechanical
      a. Description
      b. Application
    2. Hydraulic
      a. Description
      b. Application
    3. Air
      a. Description
      b. Application
    4. Electric
      a. Description
      b. Application
  D. Disc brake types
    1. Chrysler self-adjusting, self-energizing
      a. Description
      b. Application
    2. Caliper
      a. Description
      b. Application

II. Braking principles
  A. Define braking action
    1. Kinetic energy
    2. Heat
      a. Generation by friction
      b. Dissipation
    3. Transfer of energy
  B. Define friction
    1. Conditions
      a. Static
      b. Moving
    2. Factors controlling friction
      a. Area of contact
      b. Pressure
      c. Material
      d. Surface finish
    3. Coefficient of friction
      a. Surface
      b. Force
    4. Products of friction
      a. Heat
      b. Wear
  C. Brake friction requirements
    1. Stopping distance
    2. Front to rear ratio
    3. Side to side balance

III. Hydraulic brake classifications
  A. The servo brake
    1. Description
    2. Principle of operation
      a. Primary shoe
      b. Secondary shoe
      c. Servo action
    3. Adjustment procedure
  B. The non-servo brake
    1. Description
    2. Principle of operation
      a. Double end cylinder
      b. Two single end cylinder
    3. Adjustment procedure
  C. The energized brake
    1. Description
    2. Principle of operation
      a. Primary shoe
      b. Secondary shoe
      c. Anchor location
    3. Adjustment procedure
  D. The self-centering brake
    1. Description
    2. Principle of operation—servo type
      a. Anchor design
      b. Shoe design
    3. Principles of operation—non-servo type
      a. Anchor design
      b. Shoe design
    4. Adjustment procedure—servo type
    5. Adjustment procedure—non-servo type
  E. The self-adjusting brake
    1. Contact plug type
      a. Description
      b. Principle of operation
      c. Adjusting procedure
    2. Star wheel rotating type—cable-operated
      a. Description
      b. Principle of operation
      c. Adjusting procedure
    3. Star wheel rotating type—lever-operated
      a. Description
      b. Principle of operation
      c. Adjusting procedure

F. The disc brake
   1. Chrysler self-adjusting, self-energizing
      a. Description
      b. Principle of operation
      c. Adjusting procedure
   2. Caliper
      a. Description
      b. Principle of operation
      c. Adjusting procedure

IV. The parking brake classification
   A. Rear wheel type
      1. Operation
         a. Hand-operated
         b. Foot-operated
      2. Cable service
         a. Replacement
         b. Lubrication
         c. Adjustment
      3. Adjustment
   B. Transmission mounted (external type)
      1. Operation
         a. Hand-operated
         b. Foot-operated
      2. Cable service
         a. Replacement
         b. Lubrication
         c. Adjustment
      3. Band and lining service
         a. Replacement
         b. Adjustment
   C. Transmission mounted (internal type)
      1. Operation
         a. Hand-operated
         b. Foot-operated
      2. Cable service
         a. Replacement
         b. Lubrication
         c. Adjustment
      3. Shoe and lining service
         a. Replacement
         b. Adjustment

LABORATORY ACTIVITY

I. Demonstrate the adjustment procedure for each of the brake types

II. Have the trainees disassemble, identify parts, reassemble, and adjust each type of brake

Unit 11. THE HYDRAULIC BRAKE

WHEN AUTOMOBILE BRAKES are applied and the hydraulic brake system is functioning properly, the brake assembly in each wheel will share equally in the required task of stopping the vehicle. If, for any reason, there is a malfunctioning brake system component in any one wheel, erratic braking action will be the result. Therefore, it is important that the trainee understand the principles of hydraulic brake operation as well as the procedure and techniques used in correcting these malfunctions.

TIME ALLOCATION

Classroom, 8 hours; laboratory, 4 hours; shop, 35 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Brake service tool kit
III. Brake cylinder hone
IV. Electric drill (¼")
V. Tubing cutter
VI. Tubing double flare tool
VII. Used brake drums
VIII. Used brake shoes
IX. Brake lining
X. Rivets
XI. Brake tubing
XII. Cleaning chemical
XIII. Alcohol
XIV. Brake fluid
XV. Brake bleeder
XVI. Brake fluid dispenser
XVII. Brake lube
XVIII. Brake mock-up assemblies

TEACHING GUIDE

Discuss hydraulic principles in detail with emphasis on application to the brake system. A practical, rather than a theoretical, approach to the subject should be used.

A discussion session on hydraulic system components should be followed by a laboratory and practice session on service procedures.

A discussion session on mechanical components should also be followed by a laboratory and practice session on service procedures.

Components for use in the demonstration and practice session could well be used parts removed from an automobile requiring service.

DISCUSSION TOPICS

I. Hydraulic principles
  A. Pressure applied to liquids
    1. Noncompressable characteristic
    2. Pascal's principle for liquids under pressure
  B. Multiplying force
    1. Relationship of force multiplication to cylinder areas
    2. Relationship of force multiplication to distance and speed
  C. Application to the brake system
    1. Transmission of effort
    2. Multiplication of force

II. Hydraulic system components
  A. Master cylinder
    1. Function
    2. Types
    3. Nomenclature
    4. Principle of operation
    5. Reconditioning
  B. Brake lines
    1. Function
    2. Types
    3. Service procedure
  C. Wheel cylinder
    1. Function
    2. Types
    3. Nomenclature
    4. Operating principle
    5. Reconditioning
  D. Brake fluid
    1. Function
    2. Requirements
    3. Replacement

III. Mechanical components
  A. Brake pedal and linkage
    1. Function
    2. Types
    3. Mechanical advantage
    4. Service procedure
      a. Lubrication
      b. Adjustment
  B. Brake drums
    1. Function
    2. Types
      a. External
      b. Internal
      c. Internal-external
    3. Materials and construction
      a. Pressed steel
      b. Cast iron
      c. Cast iron with steel back
      d. Combination of pressed steel with centrifugally cast metal liner
      e. Cast aluminum with cast iron liner
    4. Service procedures
      a. Removal and replacement
      b. Inspection
      c. Reconditioning
  C. Brake shoes
    1. Function
    2. Types
      a. Pressed steel
      b. Cast aluminum
      c. Malleable iron
    3. Service procedures
      a. Cleaning
      b. Inspection
  D. Brake linings
    1. Function
    2. Types
      a. Woven
      b. Rigid molded
      c. Dry-mix molded
    3. Methods of attaching
      a. Riveting
      b. Bonding
      c. Clipping
  E. Brake shoe and lining service
    1. Relining shoes
      a. Old lining removal
      b. Cleaning
      c. Inspection
      d. New lining selection
      e. New lining installation
    2. Fitting lined shoes to drum
      a. Purpose
      b. Contact requirements
      c. Methods of grinding
  F. Backing plate
    1. Function
    2. Types

3. Service procedures
   a. Cleaning
   b. Inspection
   c. Anchor service
   d. Tighten mounting bolts

G. Brake springs
   1. Retracting
      a. Function
      b. Types
      c. Service procedure
   2. Hold down
      a. Function
      b. Types
      c. Service procedure
   3. Silencer
      a. Function
      b. Types
      c. Service procedure

LABORATORY ACTIVITY

I. Demonstrate service procedures for the hydraulic components of the brake system

II. Demonstrate service procedures for the mechanical components of the brake system

SHOP ACTIVITY

I. Practice the service operations for the hydraulic components

II. Practice the service operations for the mechanical components

BRAKE SERVICE PROCEDURE

Instructional Unit	Number of hours in—		
	Classroom	Laboratory	Shop
12. Diagnose Brake Problems	2	2	0
13. Service the Brake System	2	14	105
Total	4	16	105

An automobile owner has the right to expect that a brake service job will provide trouble-free braking for a long period of time. As a matter of fact, he will expect his brakes to be as good as new following a brake service job. This is a normal and practical expectation and the serviceman who performs this service will find that doing a thorough and complete job is easier, faster, and more profitable than any form of a partial repair.

The procedure for rendering this service will vary depending on whether one man or a team of men perform the service. One of the newer concepts in brake servicing is to use the team approach; i.e., assigning one serviceman per wheel. By using this method a brake service job can be completed in the shortest period of time. However, there must be a tremendous volume of brake business in a shop to warrant assigning four servicemen to a vehicle.

The purpose of this unit is to present to the trainees a basic procedure for doing a complete brake job. The following procedure is not intended to be a production-type procedure but rather one for instructional purposes. Any complete production procedure will encompass all phases of this instructional unit. The actual procedure used in a commercial establishment would vary from shop to shop depending on the type of automotive service center.

Each phase of the brake service procedure, after the diagnosis of the problem is made, should be demonstrated by the instructor on one wheel of the automobile. The trainees can then use the same procedure on the remaining wheels of the vehicle.

Unit 12. DIAGNOSE BRAKE PROBLEMS

AFTER THE REMOVAL of a wheel (preferably the right front), a quick visual inspection will determine the brake service needs of the automobile. If it is determined that a complete brake job is necessary, there is little need for further diagnosis. If, however, it is determined that the vehicle has a malfunctioning brake system, but does not need a complete brake job, a further diagnosis is necessary. The purpose of this unit is to demonstrate the procedure for this type of diagnosis.

TIME ALLOCATION

Classroom, 2 hours; laboratory, 2 hours

TOOLS AND MATERIALS

I. Hand tool kit

II. Brake service tool kit

TEACHING GUIDE

Discuss the diagnosis of brake problems with special emphasis on diagnosis techniques. Trainees should understand that a quick, accurate analysis of the problem is the first step to effective service. They should be well-schooled in typical brake system malfunctions. Following the discussion period, a demonstration of diagnosis procedures for brake systems should be given.

DISCUSSION TOPICS

I. Classify brake problems
  A. Customer interview
    1. Period of time or mileage since last brake service
    2. Previous repairs to system
    3. Nature of existing problem
  B. Test vehicle
    1. Determine area of operational malfunction
      a. Pedal action
      b. Noise or chatter
      c. Pull or lead
      d. Grab or dive
      e. Drag (one or more wheels)
      f. Fade
      g. Will not hold (normal stop)
      h. Erratic action when wet
    2. Determine needed auxiliary services and sales
      a. Tires
      b. Shock absorbers
      c. Alignment
      d. Electrical and fuel service
II. Visual inspection of the vehicle
  A. Tires
    1. Size
    2. Wear conditions
  B. Suspension system
    1. Loose parts
    2. Misalignment
  C. Brake system
    1. Worn parts
    2. Loose parts
    3. Wrong parts
    4. Improper assembly
    5. Improper adjustment
    6. Fluid leakage
      a. Brake fluid
      b. Grease
    7. Dirty conditions

LABORATORY ACTIVITY

I. Demonstrate diagnosis techniques for brake system problems

II. Diagnose brake system problems on automobiles having a variety of malfunctions

Unit 13. SERVICE THE BRAKE SYSTEM

WHEN THE DECISION IS MADE to do a complete brake job, a definite procedure should be followed so that every customer will receive the same standardized and uniform job. The purpose of this unit is to present to the trainee a procedure for servicing brake systems and their components.

TIME ALLOCATION

Classroom, 2 hours; laboratory, 14 hours; shop, 105 hours

TOOLS AND MATERIALS

I. Hand tool kit
II. Brake service tool kit
III. Electric drill (¼″)
IV. Wash pans and brush
V. Shoe-centering gauge
VI. Brake drum micrometer
VII. Oxyacetylene welding unit
VIII. Cleaning chemical
IX. Denatured alcohol
X. Brake fluid
XI. Brake lube
XII. Cotter key assortment
XIII. Household detergent

TEACHING GUIDE

The brake service procedure should be discussed with the trainees before a complete brake job is undertaken. Emphasis should be placed on the development of a standardized service procedure that will produce quality work at a highly productive rate.

A review of component service procedures should be conducted to clear up misunderstandings and to give the slower learner a chance to catch up before service work begins.

The complete service procedure for one wheel should be demonstrated by the instructor. This demonstration should be followed by student participation in the service procedure on the other three wheels of the automobile. This should be a class project with participation by all members and close supervision by the instructor.

Upon completion of the first complete brake job by the group another review of service procedures should be conducted. The class should then be divided into smaller work groups. Each work group should then be assigned a service job. Service on a variety of brake system types should be completed by each work group during the practice sessions.

DISCUSSION TOPICS

I. Prepare vehicle for service
   - A. Lift vehicle
     1. Lift point locations
     2. Safety precautions
   - B. Support vehicle
     1. Support locations
     2. Safety precautions

II. Brake system component service
   - A. Brake drums
     1. Remove
        a. Front
        b. Rear
     2. Inspect
        a. Condition
        b. Size
     3. Recondition
        a. Turning
        b. Grinding
     4. Replace
        a. Front
        b. Rear
     5. Install
        a. Front
        b. Rear
   - B. Brake shoes and linings
     1. Remove
     2. Reline
        a. Remove old lining
        b. Clean and inspect shoe
        c. Select new lining
        d. Reline shoe
     3. Replacement service
        a. Select new lined shoe set
        b. Return old set for credit
     4. Fitting lined shoes to drum
        a. Lining to drum contact
        b. Methods of grinding
     5. Installation
        a. Shoe location
        b. Retaining springs
        c. Major adjustment (non-servo adjustable anchor type)
   - C. Backing plate
     1. Clean
     2. Inspect
        a. Distortion
        b. Wear
        c. Anchor condition
     3. Free anchor if adjustable
     4. Tighten mounting bolts
     5. Replace
   - D. Wheel cylinders
     1. Reconditioning
        a. Disassemble
        b. Inspect
        c. Clean
        d. Resurface cylinder bore
        e. Clean and inspect
        f. Reassemble
     2. Replacement service
        a. Remove
        b. Replace with new cylinder
   - E. Master cylinder
     1. Reconditioning
        a. Remove
        b. Disassemble and clean
        c. Inspect
        d. Resurface cylinder bore
        e. Final clean and inspect
        f. Reassemble
        g. Install and adjust
     2. Replacement
        a. Remove
        b. Install and adjust

F. Brake lines
  1. Flexible lines
    a. Inspect
    b. Replace
  2. Steel tubing
    a. Inspect
    b. Replace
    c. Cut and double flare
G. Brake springs
  1. Retracting springs
    a. Clean
    b. Inspect condition and color
    c. Replace
  2. Hold-down springs
    a. Clean
    b. Inspect condition and color
    c. Replace
  3. Silencer springs
    a. Inspect
    b. Replace
H. Brake fluid
  1. Drain
  2. Flush
  3. Refill

III. Brake adustments

A. Major adjustment—non-servo brakes
  1. Method
    a. Eccentric anchor
    b. Cam
  2. Procedure
B. Major adjustment—servo brakes
  1. Method
    a. Eccentric anchor
    b. Sliding anchor
    c. Star wheel
  2. Procedure
C. Minor adjustments
  1. Method
  2. Procedure

IV. Brake system bleeding
A. Conditions requiring bleeding
B. Methods
  1. Manual
  2. Pressure
C. Procedure
  1. Complete system bleeding
  2. Partial bleeding
    a. Power brake unit
    b. Master cylinder
    c. One line or cylinder
  3. Problem situations
    a. High firewall mounted master cylinder
    b. Leaking wheel cylinder
    c. Series-connected wheel cylinder
    d. Parallel-connected wheel cylinder

V. Rechecking the brake job
A. Hydraulic system
  1. Master cylinder fluid level
  2. External leaks
  3. Pedal feel
B. Adjustments
  1. Wheel bearings
  2. Minor brake adjustment
C. Mechanical components
  1. Locking devices
  2. Lug nuts
D. Final road test procedure
  1. Check stopping effort
  2. Check for brake pull

VI. Prepare automobile for delivery to customer
A. Interior preparation
  1. Vacuum interior
  2. Clean steering wheel
  3. Clean glass
B. Exterior preparation
  1. Remove hand prints from tires and exterior finish
  2. Clean glass

LABORATORY ACTIVITY

I. Demonstrate the complete brake service procedure on one wheel of an automobile

II. Demonstrate machine operations necessary for component reconditioning

SHOP ACTIVITY

I. Practice the complete brake service procedure using a selected group of automobiles having a variety of brake system types

II. Practice the service procedure for partial system repair using a selected group of automobiles having a variety of brake problems

APPENDIX A

HAND TOOLS AND SPECIALIZED TOOL KITS

1. Student Hand Tool Kit

SUGGEST: One tool kit be issued for each group of three trainees

Tool box
Sliding bar handle
Speed handle
Extension bar 10″
Ratchet wrench
Universal joint
Extension bar 5″

Socket set containing:

7/16″	5/8″	13/16″	1 1/16″
1/2″	11/16″	7/8″	1 1/8″
9/16″	3/4″	15/16″	1 1/4″
19/32″	25/32″	1″	

Hex head wrenches containing:

3/64″	7/64″	9/16″	3/8″
1/16″	1/8″	7/32″	
5/64″	9/64″	1/4″	
3/32″	5/32″	5/16″	

Punch set containing point sizes:

3/16″	1/4″	5/16″	3/8″

Open-end wrench set containing:

1/4 & 5/16″	5/8 & 11/16″	1 & 1 1/8″
3/8 & 7/16″	3/4 & 13/16″	1 1/16 & 1 1/4″
1/2 & 9/16″	7/8 & 15/16″	

Offset box wrench set containing:

3/8 & 7/16″	9/16 & 5/8″	11/16 & 13/16″	15/16 & 1″
7/16 & 1/2″	5/8 & 11/16″	3/4 & 7/8″	
1/2 & 9/16″	5/8 & 3/4″	7/8 & 15/16″	

Diagonal cutter 6″
Hose clamp pliers
Gripping pliers 8 3/4″
Hammer—Ball peen 4 oz.
Feeler gauge—wire type
Philips screwdrivers:
No. 1 bit and No. 2 bit
Hack saw frame and blade
Combination pliers 7 1/2″
Battery cable pliers
"Vise Grip" plier 10″
Feeler gauge—ribbon type
Screw driver set containing:
4″–6″–8″–12″ blades
Adjustable wrenches 6″ and 10″
Pry bar 12″
Grease and hub cap tool

Cost estimate per kit $200

2. Instructor Hand Tool Kit

Include all tools listed in Student Hand Tool Kit plus the following additional tool assortment:

Additional tool box
Ignition wrench set
Chisel and punch set
Tap and die set ¼" to ½"
Needle nose pliers
Diagonal cutters 5", 7"
Battery pliers
Plastic tip hammer
Ball peen hammer 12 oz.
Brake cylinder hone
Seat covers
Feeler gauge—strip type
Torque wrench 1—150-inch pound
Philips screwdriver set
Clutch blade screwdriver set
Jumper wires 6", 12"
Complete set files
Midget socket wrench set
Screw and stud extractor set
Pipe wrench set 8", 10", and 12"
Re-threader die sets N. F. and N. C.
Gripping pliers 5", and 7½"
Brake spring pliers
Snap ring pliers:
internal
external
Pry bar 6", 16"
Fender covers
Spark plug wire gauge
Hacksaw frame and blades
Torque wrench 0—150-foot pound
Standard tip screwdriver set
Steel tape measure 12 ft.
Nut cracker 5/16" to 13/16"

Cost estimate per kit $700*

*Including the $200 Student Hand Tool Kit

3. Exhaust System Service Tool Kit

SUGGEST: One kit available per class

Tool box
Muffler cutting tool
Round-out tool
Air tool with muffler accessories
Muffler—tailpipe tool
Tailpipe expander
Tailpipe cutter

Cost estimate per kit $100

4. Brake Service Tool Kit

SUGGEST: Three kits available per class

Tool box
Brake spring tool
Brake shoe spring tool
Brake adjusting tools
Brake bleeder hose
Brake cylinder hone
Chrysler total contact spring tools
Grease cap puller
Brake spring pliers
Cylinder clamps
Brake bleeder box wrench:
3/8"—3/8 & 7/16"—1/4 & 3/8"
Master cylinder fill plug wrench
Tubing cutter and flare kit
Chrysler parking brake tool

Cost estimate per kit $75

5. Alignment Service Tool Kit

SUGGEST: Two kits available per class

Tool box
Suspension tool set including:
Wrenches for: Ford, Falcon, Mercury, Pontiac, Corvair, Valiant, Lancer, Rambler, Plymouth,

Dodge, Chrysler, DeSoto, Chevrolet, Oldsmobile, Buick
Tire pressure gauge
Ball joint removing and installing socket set
Steel tape measure 12 ft.
16-oz. hammer
Pitman arm puller
Tie-rod sleeve spreader
Drag line sockets
Caster—camber wrench set
Ounce spring tension gauge
Wheel cover tool
Tie rod separators
Pipe wrench 12″
¾-drive socket set, 16 sockets 1″ to 2″ by 16th's sliding bar handle extensions 5″, 8″ Adapter ½ to ¾ drive

Cost estimate per kit $200

APPENDIX B

GENERAL SHOP EQUIPMENT AND TOOLS

	Suggested Quantity
Four-ton floor jack	2
Safety jack stands (pairs)	6
Creepers	4
Cleaning tank (re-circulating type)	1
Gas welding unit	2
Air compressor 5 h.p.	1
Work benches 8 ft.	6
Bench vises	6
Bench grinder	1
Hydraulic fluid dispenser	1
Heavy duty drill ½" capacity including drill bits	1
Heavy duty drill ¼" capacity including drill bits	2
Vacuum cleaner	1
Impact air wrench ½" drive	4
Impact air wrench socket kit	4
Rim or lug wrench	2
Air hose (25-ft. lengths)	3
Water hose (50-ft. lengths, ½" diameter)	2
Water drain pans	3
Oil drain and cleaning pans	3

Cost estimate $3,800

APPENDIX C

BASIC EQUIPMENT AND TOOLS

1. Service Orientation and Maintenance
(SEE SECTION I)

Equipment	Suggested Quantity
Chassis lubricator	1
Gear lubricator	1
Specialized lubrication tools	1 each
hydraulic extension	
grease injector adapter	
service adapter	
universal adapter	
fitting removal tools	
suction gun	
hand gun	
Wheel bearing packer	2
Engine cleaning gun	1
Radiator reverse flushing tool	1
Thermostat tester	1
Radiator and cap pressure tester	1
Spark plug cleaner	1
Battery-starter tester	3
Battery charger	2
Portable headlight aimer (pair)	2
Power tire changer	1
Tube vulcanizing unit	1
Bumper jack	2
Muffler air hammer with cutting tools (set)	1
Tools	
Hand oiler—squirt type	9
Flexible spout oil can	3
Oil can puncture spout	1
Radiator filler can	1
Transmission fluid dispenser	1
Wash pail and mitt	2
Chamois	2
Battery water container and syringe	1
Fan belt tension gauge	2
Wheel grease cap puller	1
Wheel and axle puller	1
*Tire pressure gauge	
Tire probe or pick	3
Tire bead expander	1
Rubber mallet	1
Tube-tire buffer	1
Patch roller	1
Tire testing water pan	1

Hydrometer—radiator	1
Hydrometer—battery	3
Spark plug wire gauge	3
Spark plug tap	1
Battery terminal cleaner	3
Battery cable pliers	3
Battery cable puller	3
*Tailpipe expander tool	
*Muffler cutting tool	
Drain plug wrench	1

Cost estimate $2,500

*Listed in Specialized Hand Tool Kits Section

2. Electrical and Fuel Section

(SEE SECTION II)

Equipment	Suggested Quantity
*Battery-starter testers	
Distributor tester	1
Tach-dwell meter	3
Volt-amp meter	3
Alternator tester	3
Diode testing instrument	1
*Battery charger	
Compression gauge	2
Cylinder leakage tester	2
Ohmmeter	3
*Battery hydrometer	
Timing light	3
Ignition advance tester	2
*Spark plug cleaner	
Armature lathe	1
Armature growler	2
Oscilloscope	2
Exhaust gas analyzer	1
Battery light load tester	2
Vacuum gauge	3
Bench press	1
Condenser tester	1
Scope simulator	1
Variable field rheostat	1
Fuel pump tester	2
Tools	
Ignition wrench kit	3
Torque wrench 1–150 ft. lbs.	3
Stethoscope	1
Battery terminal cleaner	3
Jumper wires 6″, 12″ (each)	4
Insulated pliers	4
Spark plug adapters set	3

Vacuum gauge fittings set	3
Distributor tool kit	3
Voltage regulator tool kit	1
Carburetor tool kit to service	2
Rochester	
Carter	
Ford	
Plastic 1-qt. container	1
*Oil cans	
Battery post adapter	3
Flaring tool kit	1
*Battery cable puller	
*Battery cable pliers	
Battery water container and syringe	1
Spring tension gauge	1
Alternator service tool kit	2
*Spark plug tap	
Gas can (5-gal.)	1

Cost estimate $5,000

*Listed in Service Orientation and Maintenance Operation Equipment Section

3. Suspension and Brakes Section

(SEE SECTION III)

Equipment

	Suggested Quantity
Semi-portable alignment machine, including attachments	2
Ball joint checker	1
Toe-in gauge	2
Magnetic gauges	2
Lifting jacks (pair)	2
Torsion air-suspension gauge	1
Wheel balancer—off-the-car type	1
Wheel balancer—on-the-car type	1
Air-cutting tool including attachments	1
Brake drum reconditioner	1
Brake bleeder	2
Brake shoe grinder	1
Brake drum gauge	2
Seal pullers and drivers	1
*Hydraulic fluid dispenser	
**Wheel bearing packer	

Tools

Refer to Hand Tool Kits

Cost estimate $6,000

*Listed in General Shop Equipment and Tools Section

**Listed in Service Orientation and Maintenance Operations Section

APPENDIX D

SUGGESTED OPERATING SUPPLIES

Penetrating oils or solvents
Brake fluid
Brake rivets
Cotter key assortment
Bolt and nut assortment
Washer assortment
Lintless tape (bias)
Heat-control valve solvent
Spark plug gaskets
Gasket cement
Grease fitting assortment
Wheel bearing grease
Rubber lubricant
Power steering fluid
Tire crayon
Tire and tube patches
Filler rubber compound
Engine cleaning chemical or shampoo
Parts cleaning solvent
Fender cover (2 per vehicle)
Alcohol
Cleaning solvents or chemicals
Wheel weights
Commutator paper
Emery cloth
Carburetor cleaner
Spark plug cleaning compound
Oil
Rubber cement
Tape (electrical)
Chassis grease
Lithium grease
Brake lubricant
Powdered graphite and dispenser
Insulated wire
Insulated wire connectors
Sandpaper
Tire plugs
Car wash soap
Cleaning cloths (10 per student per week)
Iron wire
Seat covers (1 per vehicle)
Wire brushes
Parts cleaning brushes
Janitor supplies

Cost estimate $1,000

APPENDIX E

COST SUMMARY

	Class of 15 students	
Specialized Hand Tool Kits Section		
Student Hand Tool Kit (5)	$1,000	
Instructor Hand Tool Kit (1)	700	
Exhaust System Service Tool Kit (1)	100	
Brake Service Tool Kit (3)	225	
Alignment Service Tool Kit (2)	400	
Total		$ 2,425
General Shop Equipment and Tools Section		3,800
Basic Equipment and Tool List		
Service Orientation and Maintenance Operations Section	$2,500	
Electrical and Fuel Section	5,000	
Suspension and Brakes Section	6,000	
Total		13,500
Suggested Operating Supplies		1,000
Grand Total		20,725

SUGGESTED REFERENCE MATERIALS

A. C. Charging Circuits, Anderson, Ind., Delco-Remy Division, General Motors Corporation

A. E. A. Alternators, Technical Training Manual, Detroit, Mich., Automotive Electrical Association

Ammco Brake Service Manual, Detroit, Mich., Marshalls, Inc.

Automatic Transmission Service Guide, Newark, N. J., Lincoln Technical Institute

Barr and Flocco, The Automobile Electrical System, Philadelphia, Pa., Chilton Books

Barrett Training Manual, Brakes, Lansing, Mich., John Bean Division, FMC Corporation

Bostwick and Barr, The Automotive Electrical System, Volume III, Automotive Job Sheets, Philadelphia, Pa., Chilton Books

_____ The Engine with Supplement on the Fuel System, Volume I, Automotive Job Sheets, Philadelphia, Pa., Chilton Books

Chek-Chart Automotive Service Guide, Chicago, Ill., Chek-Chart Corporation

Cranking Circuits, Anderson, Ind., Delco-Remy Division, General Motors Corporation

Crouse, Automotive Electrical Equipment, New York, N. Y., McGraw-Hill Book Co., Inc.

_____ Automotive Fuel, Lubricating and Cooling Systems, New York, N. Y., McGraw-Hill Book Co., Inc.

_____ Automotive Mechanics, New York, N. Y., McGraw-Hill Book Co., Inc.

_____ Automotive Transmissions and Power Trains, New York, N. Y., McGraw-Hill Book Co., Inc.

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